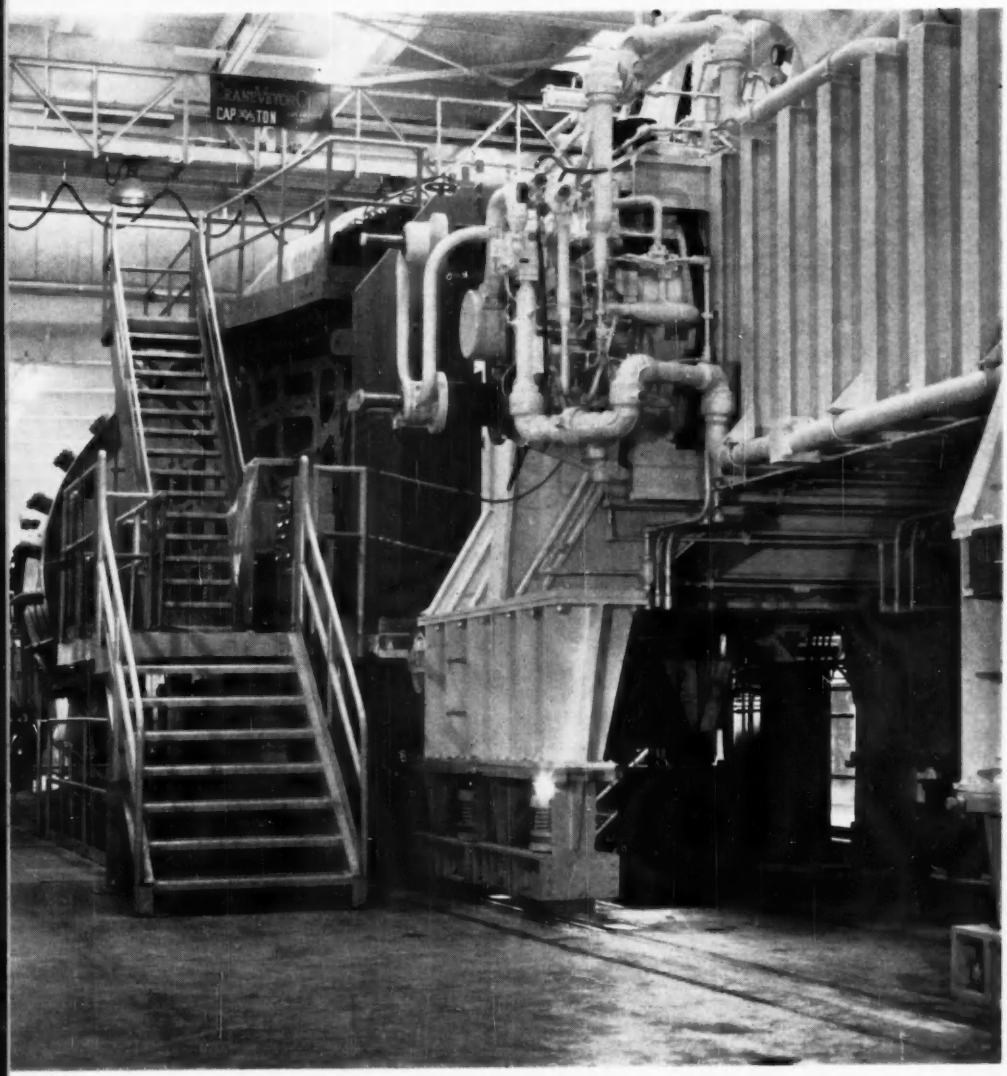
Compressed Air Magazine

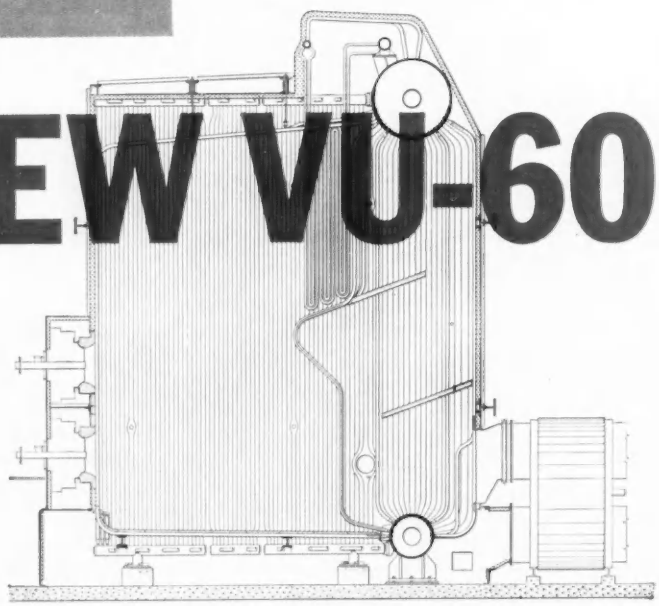


MARCH 1961

IN THIS ISSUE:

Now...a completely self-cased, MODULAR BOILER

C-E's NEW VU-60



DESIGN HIGHLIGHTS OF THE VU-60

Modular construction makes it possible to assemble custom designs from standardized components.

Boiler can be proportioned for best combustion, heat absorption and gas flow even when space conditions are limited or difficult.

Completely self-cased, the VU-60 is an all-welded gas-tight and pressure-tight envelope of finned furnace and boiler tubes. This results in less non-working weight per pound of steam capacity.

No external ductwork. The bottom of the boiler is a plenum chamber which allows air to flow direct from the air heater to the burner windbox.

Number of field-welded pressure parts is greatly reduced.

Cross flow baffling and symmetrical boiler bank mean low draft loss, no sluggish gas flow in any pass.

Requires only a simple, reinforced concrete slab. No conventional roller supports required.

Paneled construction cuts erection time.

No air heater supporting steel is required.

For pressurized or induced draft firing.

VU-60 SPECIFICATIONS

Capacities:	100,000 to 250,000 lb per hr
Design pressures:	250, 500, 750, 1000 psi
Steam temperatures:	To 900 F
Fuels:	Oil and/or gas
Firing:	Horizontal (front wall) or tangential
Size increments:	Depth – twelve Width – eight Height – three
Stream drum sizes:	Four

The VU-60 Boiler is a new and logical extension of C-E's service-proved VU series. Like all VU units, it is completely integrated, symmetrical in design, uncluttered and uncomplicated. Based on a standardized modular concept, it offers greater flexibility, yet stays within the bounds of solid and proven practice.

The VU-60 is a functional boiler. Completely self-cased, the exterior walls of this unit (furnace and boiler) are composed of finned tubes, shop welded into panels. The fins between panels are field welded to form a gas- and pressure-tight structure. Insulation is applied directly to the outside of these walls and is covered by pre-formed, field installed metal lagging. Thus non-working weight and bulk is reduced to a minimum.

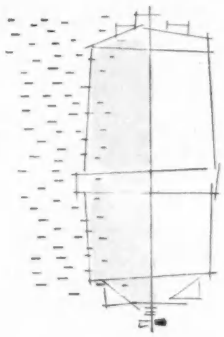
The VU-60 is economical, it is dependable, it is accessible. It is easy to install and will meet your most exacting steam needs. Why not write for further information, or, if you prefer, contact the C-E office nearest you.

COMBUSTION C-E ENGINEERING

General Offices: Windsor, Conn.
New York Offices: 200 Madison Avenue, New York 16, N. Y.
Canada: Combustion Engineering-Superheater Ltd.

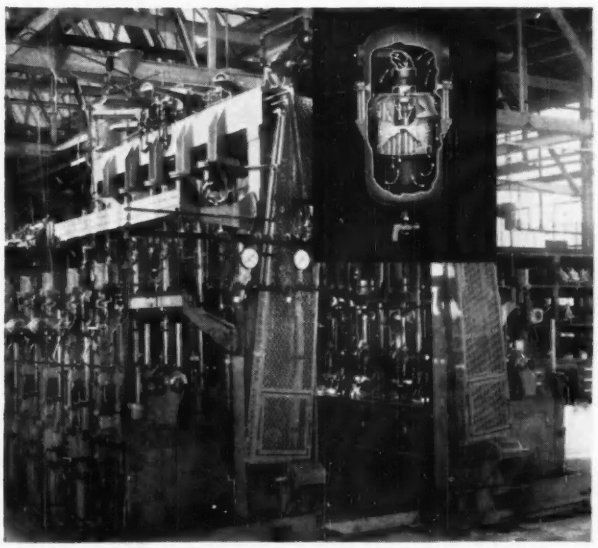
C-300A

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE



DOLLINGER
DRY FILTER
SPECIALISTS
FOR 40 YEARS

ELIMINATE DIRT FROM BOTTLE-FORMING OPERATION



Staynew Filters prevent air-borne dust and dirt from being blown into molten glass on bottle-forming machines of the Hartford-Empire Company Division of Emhart Mfg. Co., Hartford, Connecticut.

DOLLINGER STAYNEW FILTERS keep compressed air lines clean, help Hartford-Empire consistently produce a clearer, more perfect bottle with fewer rejects. Applied to air lines of bottle-forming machines, the filters remove moisture, dirt and dust particles down to five microns . . . or less than 0.0002 inches!

MICRO-FILTERING LIKE THIS is only part of the story. Hartford-Empire finds that Staynew Pipeline Filters offer the largest active filtering area in relation to the space occupied; they maintain low velocity and resistance to flow, thus helping to keep proper line pressures and save horsepower. Staynew Filters also eliminate the need for frequent cleaning; when cleaning is necessary, simple opening of swing bolts permits removal of filter element without breaking pipe connections.

DESIGNED FOR ANY TYPE OF SERVICE, Staynew Filters may be the answer to your filtration problem. Find out more information by talking to your Dollinger representative, or write for Bulletin 200. Dollinger Corporation, Industrial Products Division, 7 Centre Park, Rochester 3, New York.

PROTECTOMOTOR

STAYNEW FILTERS

DOLLINGER

LIQUID FILTERS • PIPE LINE FILTERS • INTAKE FILTERS • HYDRAULIC FILTERS • ELECTROSTATIC FILTERS • MIST COLLECTORS • DRY PANEL FILTERS • SPECIAL DESIGN FILTERS • VISCOUS PANEL FILTERS • LOW PRESSURE FILTERS • HIGH PRESSURE FILTERS • AUTOMATIC VENTILATION FILTERS • NATURAL GAS FILTERS • SILENCER FILTERS

HOW TO SIMPLIFY PIPE LINE INSTALLATIONS

To help you get the job done faster, easier and more economically, NAYLOR offers a pipe and coupling combination to simplify pipe line installations.

The characteristic lockseamed, spiralwelded NAYLOR structure gives you pipe that is light in weight without sacrifice of strength and safety. It's easy to transport, handle and install. You save time, trouble and money right down the line.

NAYLOR Wedgelock couplings fit into this economy picture, too. They simplify and speed connections since a hammer is the only tool required to connect or disconnect them, and joints can be made up with only one side of the pipe in the open.

For air, water and ventilating service, it will pay you to consider this dependable NAYLOR pipe and coupling combination.

NAYLOR Wedgelock couplings make a positive connection, securely anchored in standard weight grooved ends.

Write for Bulletin No. 59.

NAYLOR PIPE *Company*

1245 East 92nd Street, Chicago 19, Illinois

Eastern U. S. and Foreign Sales Office: 60 East 42nd Street, New York 17, N. Y.

Volume 66 Number 3

March 1961

Compressed Air MAGAZINE

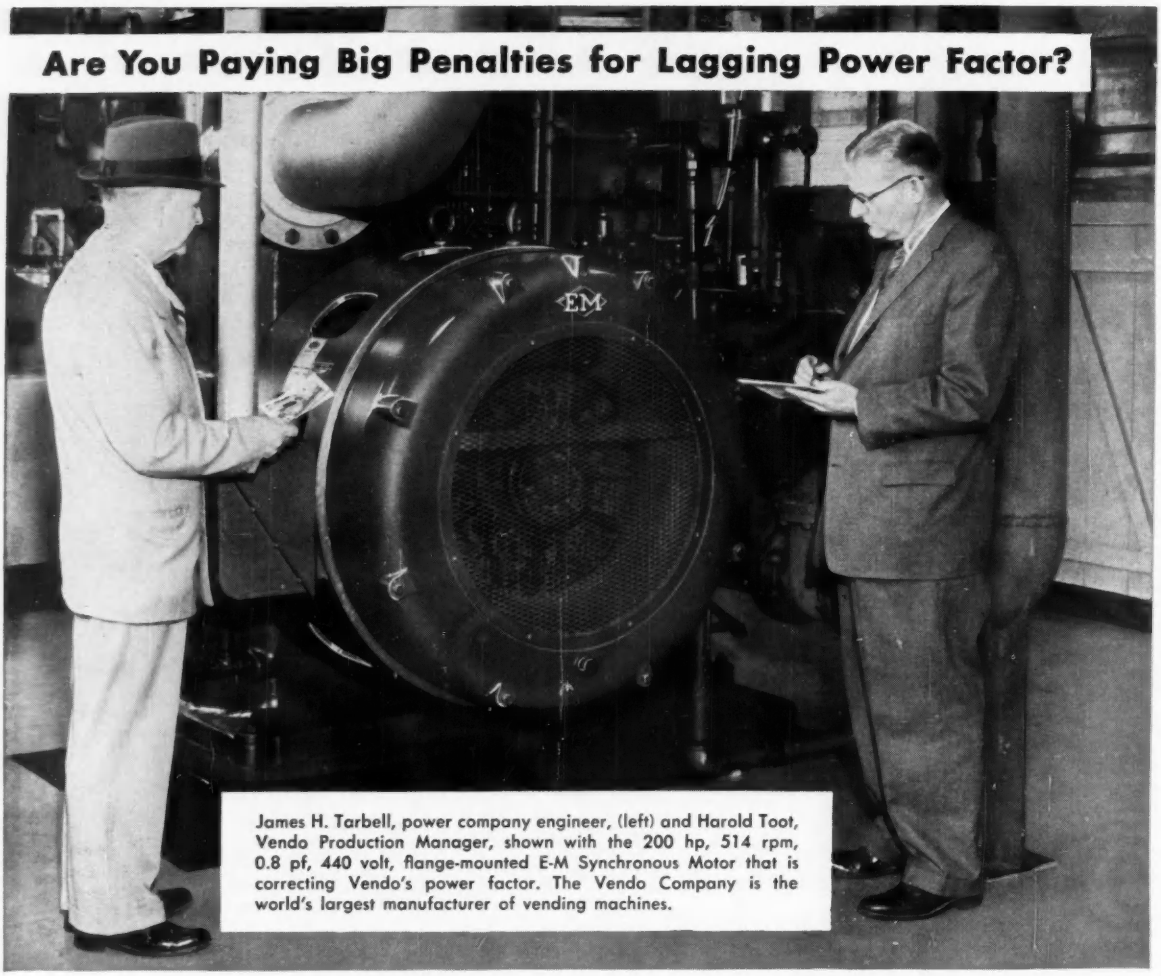
BPA

Editorial, advertising and publication offices: 942 Memorial Parkway, Phillipsburg, New Jersey. Annual subscription, United States and possessions, $5: foreign, $7; single copies, domestic $0.50, foreign, $0.70. Compressed Air Magazine is indexed in Industrial Arts Index and in Engineering Index. Microfilm volumes (1940 to date) are available from University Microfilms, Inc. Published monthly by Compressed Air Magazine Company: A. W. Loomis, President; L. C. Hopton, Vice President; C. H. Biers, Secretary-Treasurer.

on the cover

The bulky equipment pictured is designed to contain a mighty wind that blows round scale models of missiles and aircraft. It's the supersonic wind tunnel at Douglas Aircraft Company's Aerophysics Laboratory. The section in the right foreground is the downstream or discharge end of the tunnel and is designed to be rolled away from the test chamber and throat sections. When open, model changes are easily made. The test chamber is on a line with the first landing of the stairway.

Are You Paying Big Penalties for Lagging Power Factor?



James H. Tarbell, power company engineer, (left) and Harold Toot, Vendo Production Manager, shown with the 200 hp, 514 rpm, 0.8 pf, 440 volt, flange-mounted E-M Synchronous Motor that is correcting Vendo's power factor. The Vendo Company is the world's largest manufacturer of vending machines.

Vendo Company Corrects Power Factor...SAVES $450 A YEAR! with an E-M Synchronous Motor

The Vendo Company, Kansas City, Missouri learned its plant was operating at a lagging power factor condition when expanded production facilities required more compressed air. A study by Vendo's engineers and Kansas City Power & Light Company showed an 0.8 leading power factor synchronous motor compressor drive would save them money. Here's how:

Vendo's power contract provides a penalty of 20 cents a month for every reactive kva exceeding one-half the maximum kilowatt demand. *This was costing Vendo $33.00 per month, or $396.00 a year!*

A 20 cents a month bonus is granted for every kilovar the reactive demand falls short of one-half the maximum kilowatt consumption. A 200 hp E-M Synchronous Motor with 0.8 pf would provide enough reactive kva for Vendo to operate at a *leading* power factor and earn a monthly credit of $4.60. Vendo's power bill would then be reduced by $37.60 a month, or $451.20 a year!

Vendo installed the recommended E-M Synchronous Motor . . . and has been enjoying a reduced power bill ever since. You, too, can make a big saving in your plant power bill by correcting your power factor with highly efficient E-M Synchronous Motors.

Learn more about Power Factor. Call your nearby E-M Sales Engineer and write for your free copy of the new E-M 24-page brochure, *The ABC of Power Factor.*

E-M

1106-TPA-2187

ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA

Specialists in making motors do
EXACTLY WHAT YOU WANT THEM TO

big performer

---in the small pump field

COMPACT, MULTI-PURPOSE "K" Line Motorpumps are designed with the same "custom engineering" reflected in the largest Ingersoll-Rand pumps. And in all types of installations the rugged "K" Line is proving its dependability and efficiency.

"K" Line Motorpumps are stocked by Ingersoll-Rand distributors for fast, off-the-shelf delivery to meet any specification from ⅓ to 25 hp, up to 775 gpm, heads to 190 feet. Every pump is boxed and labeled and ready for immediate hookup.

For complete details on the I-R "K" Line Motorpump write today for latest catalog data. Or see your I-R Distributor.

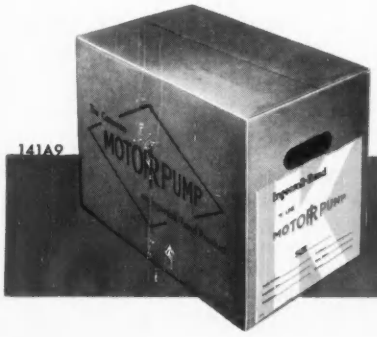
over a century IR *of pump progress*

from the leading manufacturer . . .

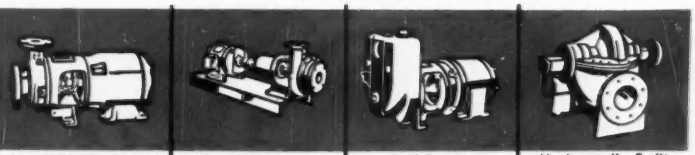
Ingersoll-Rand

11 Broadway, New York 4, N. Y.

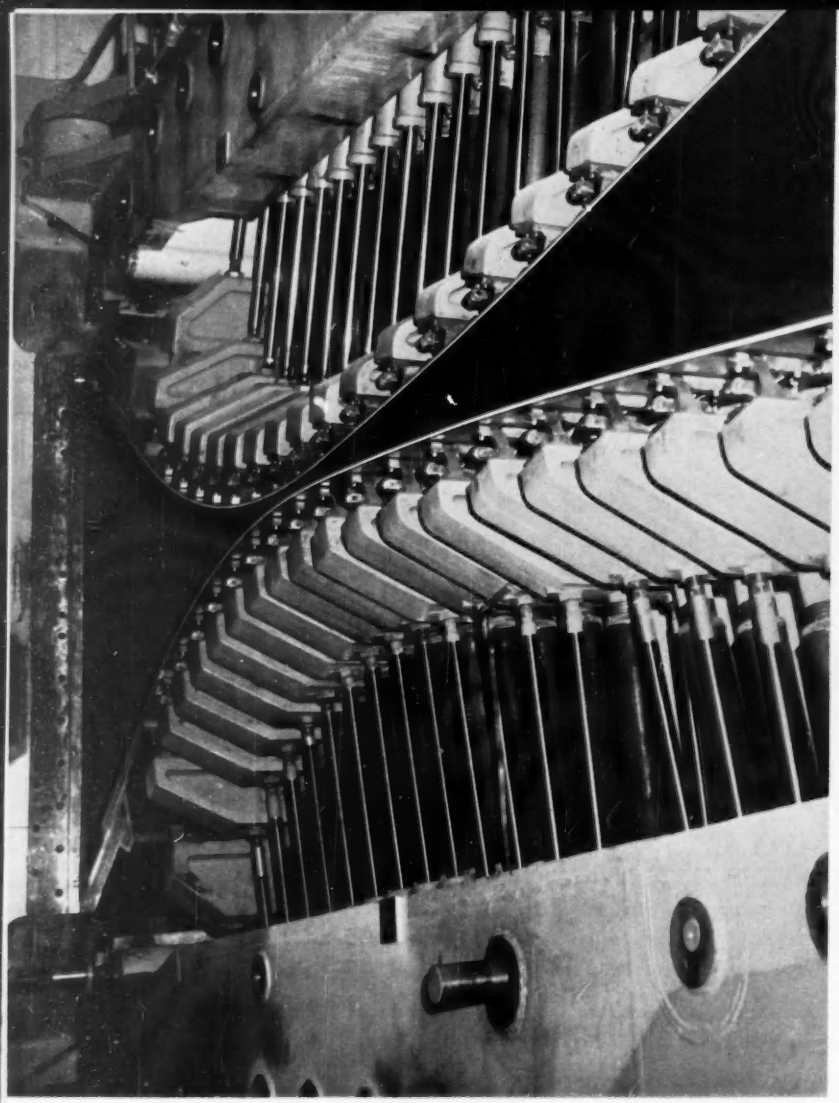
141A9

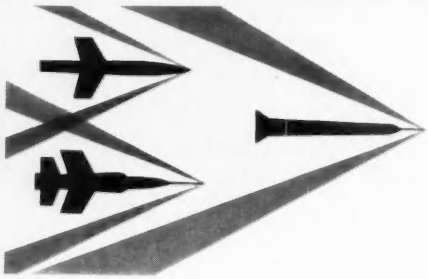


OTHER I-R PUMPS AVAILABLE



Motorpumps | Cradle-Mounted Pumps | Self-Priming Motorpumps | Horizontally-Split Pumps





Blowdown Testing

R. J. Nemmers

THERE is a good-sized agglomeration of machinery in a Southern California plant that, on first glance at some astonishing figures, might seem to qualify the establishment as one of the world's most inefficient users of electric power. Energy goes into the plant at a rate of 66 KV; "I" is measured in terms of microvolts.

Actually the output of this plant is facts, not hardware or electrical energy. Douglas Aircraft Company's Aerophysics Laboratory is a recent addition to the nation's growing number of test facilities designed to blow air around and through precision scale models of missiles and aircraft.

Today the complex is made up of three wind tunnels, all of the blowdown variety: in this type tunnel, large storage tanks are charged with compressed air over a relatively long period of time. Then the air is released through a test chamber during a shorter span. The blowdown tunnel is distinctly different from the so-called "hot shot" tunnels which have a flow duration of only milliseconds. Douglas's three tunnels have stable flow periods ranging to more than 200 seconds. A continuous-flow tunnel, of course, is one in which the installed compressor plant can maintain a continuous flow through the tunnel for any required length of time. Blowdown tunnels do not require the large compressor installations of continuous flow tunnels, yet with proper instrumentation, can derive essentially the same data with no greater error.

The Tunnels

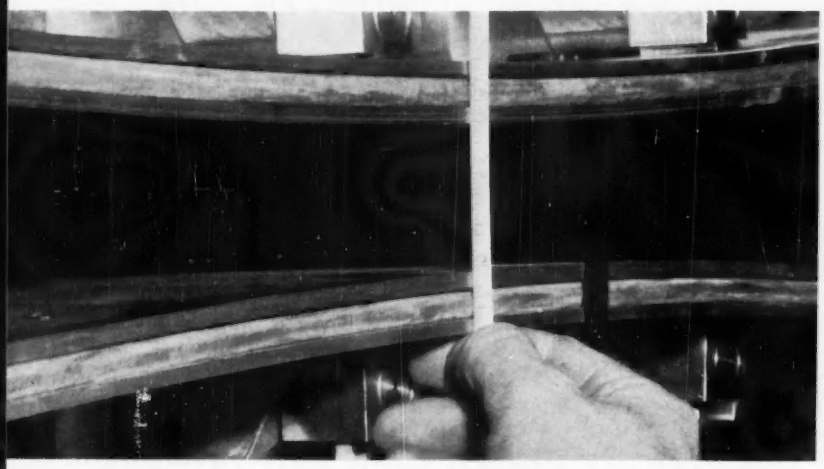
The first of the Douglas tunnels was "blown in" during January 1957. Having a 1x1-foot test chamber, the plant is termed a trisonic tunnel. It can simulate speeds of Mach 0.2 (subsonic) through Mach 1 (sonic) to Mach 3.5 (supersonic).

The next of the tunnels to go into operation was the 4x4-foot one on which acceptance tests were completed in July 1959. This is, at present, a supersonic tunnel having a capacity of Mach 1.4 to 5.0. The last of the tunnels, on which finishing touches were recently completed, is a hypersonic (Mach 5.0 to 10.0) plant.

The 1x1 tunnel is used primarily for the development of wind tunnel configurations and testing techniques. Although its small size restricts its usefulness for the testing of models, the tunnel does lend itself to preliminary tests on simplified models. Such tests as these provide a rapid check on experimental designs and theories at a minimum cost and aid in the determination of which designs are worth exhaustive investigation.

The supersonic tunnel provides for testing large models at relatively high air densities and closely simulates full-scale flight conditions. Both complete models of aircraft and components such as wings, engine inlets, etc., can be checked out in the 4x4-foot facility.

The hypersonic tunnel will fill the



THROAT SECTION A battery of 56 hydraulic jacks warp a pair of 0.87-inch-thick stainless plates to form the nozzle of the 4x4-foot tunnel. At far left is an over-all view; at left is a close-up of the throat at Mach 5 setting. The $1^3/_4$-inch gap is shown here approximately half size.

need for the measurement of pressures, temperatures and dynamic characteristics in the aerodynamic flight regime of missiles and space craft. Complete models will be examined in this tunnel as well as such component parts as re-entry bodies and control surfaces.

Air Flows

Flow through a blowdown tunnel is a complicated thing in many respects. The trick is to get a stabilized flow through the test section and one that is reproducible at will for any given wind speed. This removes incident or irrelevant variables, leaving the model configuration and its angle of attack as the independent variables.

The trisonic (1-foot) and the supersonic (4-foot) tunnels utilize a thermal mass composed of steel tubing in the storage tanks to reduce the temperature drop of the rapidly expanding air to a maximum 30° F. The hypersonic (2-foot) tunnel, operating as it does at high speeds, requires a heater in the air stream to prevent liquefaction of the air. Air for the supersonic and hypersonic tunnels is dried to a −50° F dew point.

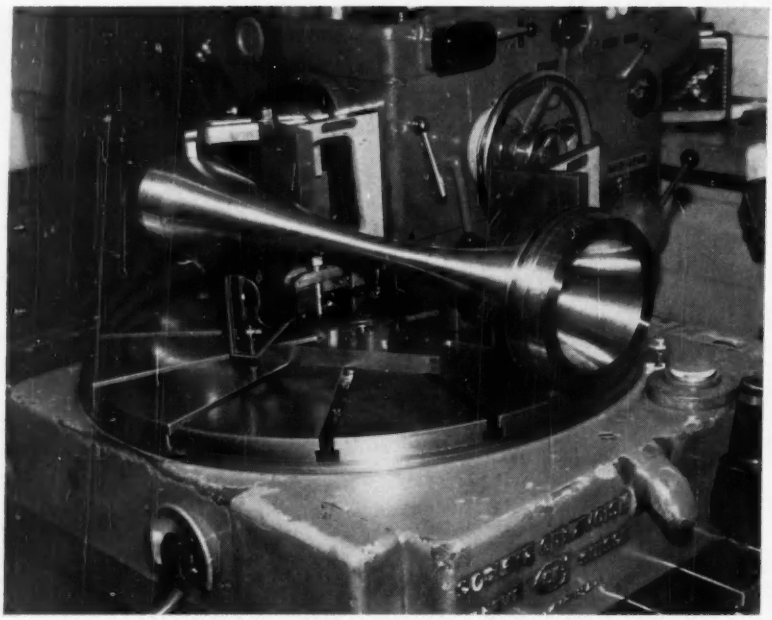
Air is released from the storage tanks into the tunnels through quick opening valves. In the supersonic tunnel, the 24-inch valve goes from full closed to full open in 0.3 second; the hypersonic valve (8 inches in diameter) reacts in 0.5 second.

The operation of a tunnel at transonic (Mach 1) speeds presents problems in stabilization of the air flow through the test section that are not encountered at speeds above or below that range. At near sonic speeds a shock wave will stand from the model to the walls of the test section. The presence of this shock wave, of course, interferes seriously with test results. It has been found that inserting a porous walled test section will relieve the pressure field about the model created by this shock wave, thus making it possible to more nearly simulate flight conditions. There are size restrictions on the model even with the porous walled section in place; it cannot be too large.

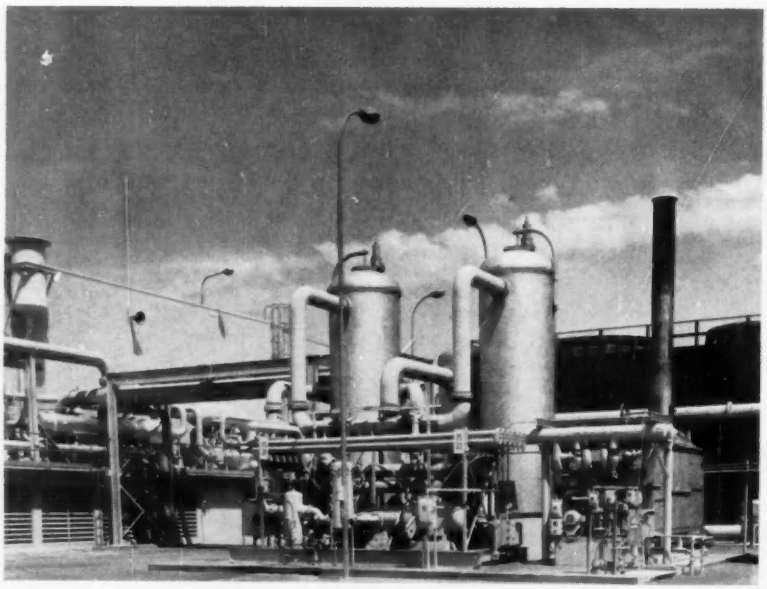
The 1x1 tunnel is equipped with such a porous test chamber and plans are being made to equip the 4x4 tunnel in the same way so that it, too, will become suitable for trisonic work. To assist in the design of the 4x4 tunnel, the present 1x1 plant is being equipped with some special modifications and will be used as a pilot plant in these studies.

Essentially the modification work consists of piping the annular space surrounding the porous walls to a point farther down stream. This will, in effect, work as an ejector or venturi suction device. The necessary studies and modifications, it is believed, will be completed so that initial runs on the 4x4

AERIAL VIEW The Douglas Aerophysics Laboratory is viewed here from the air. The 66-KV substation feeding the facility is in the center foreground; at left is the cooling tower; at right, the administration building and 4x4-foot tunnel; at left center, the hypersonic tunnel building; and behind it, the air driers. The 1x1 trisonic plant is out of the picture at the left. The four white tanks (center) hold air at 525-psia pressure for the supersonic tunnel.



HYPERSONIC NOZZLE The sleek hourglass machining above is the Mach 10 nozzle for the Douglas hypersonic tunnel. Each time a change in Mach number is made, a different nozzle must be substituted in the tunnel. Designing and making these nozzles is quite a job in itself and is accomplished by the machine shop at the Laboratory. Other than the complex aerodynamic factors that must be considered in the design are such things as heat transfer and structural stability. The 12-inch rule on the turntable indicates the over-all dimensions of the nozzle. Through this relatively small throat, the entire output of a 1000-hp compressor over a span of many minutes must pass in a matter of only seconds.



DRIER INSTALLATION To assure a dry air supply to the supersonic and hypersonic tunnels, the Pritchard Hi-Dryer installation shown here receives air from the compressors and removes sufficient water to lower the dew point to —50° F. A thermal mass in the 4x4 tunnel storage tanks, which limits the temperature drop to a maximum 30° F, is thus sufficient to prevent condensation in the tunnel. In the hypersonic test set up, however, a heater is required in the air stream not only to prevent condensation but also to prevent liquefaction of the air as it expands. The louvered sections in the building at the left lead to the intake-air filters.

tunnel at transonic speeds can be made during July. This, of course, will greatly increase the capacity of the Aerophysics Laboratory to handle all problems related to missile and aircraft research work.

Future Expansion

In addition, it is planned to install a hypervelocity impulse tunnel that will extend test capabilities to Mach 20. This will be a shock tunnel with flow durations of about 10 milliseconds. Further, a light-gas-gun ballistic range is planned, into which models may be launched at velocities to 15,000 feet per second (in excess of 10,000 mph). The test range will be 100 feet in length and may be evacuated or pressurized with a variety of different gases thus simulating conditions not only on earth and in space but around other planets as well. Rain and dust erosion studies thus could also be simulated under actual flight conditions.

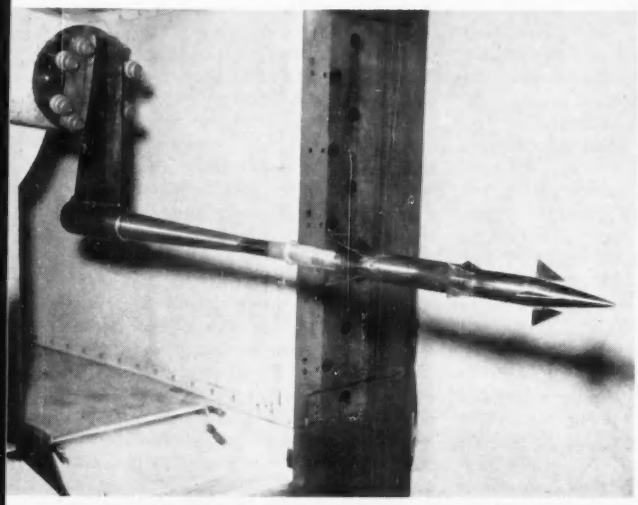
Accomplishments

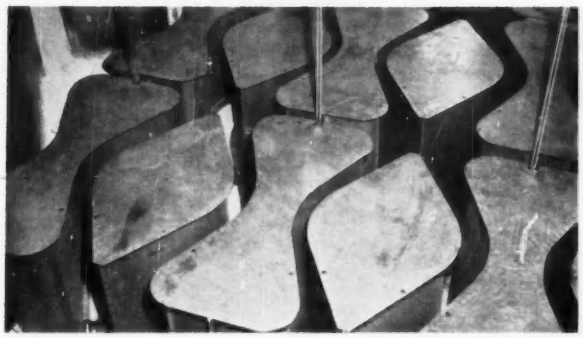
Although using a relatively new facility, the Douglas Aerophysics Laboratory personnel have come up with an impressive list of accomplishments. Aircraft and missiles on which design studies have been performed at the tunnels include the Nike Zeus antimissile missile. The weapons system based on the sleek killer scored on a dramatic test last fall when it shot down another Hercules missile at a height of more than 100,000 feet and at a distance of some 30 miles from the defender's launch point. Both missiles in the test carried warheads. Other major Douglas contracts which have employed the tunnels, or will utilize them in the future, include *Skybolt* and *Missileer*.

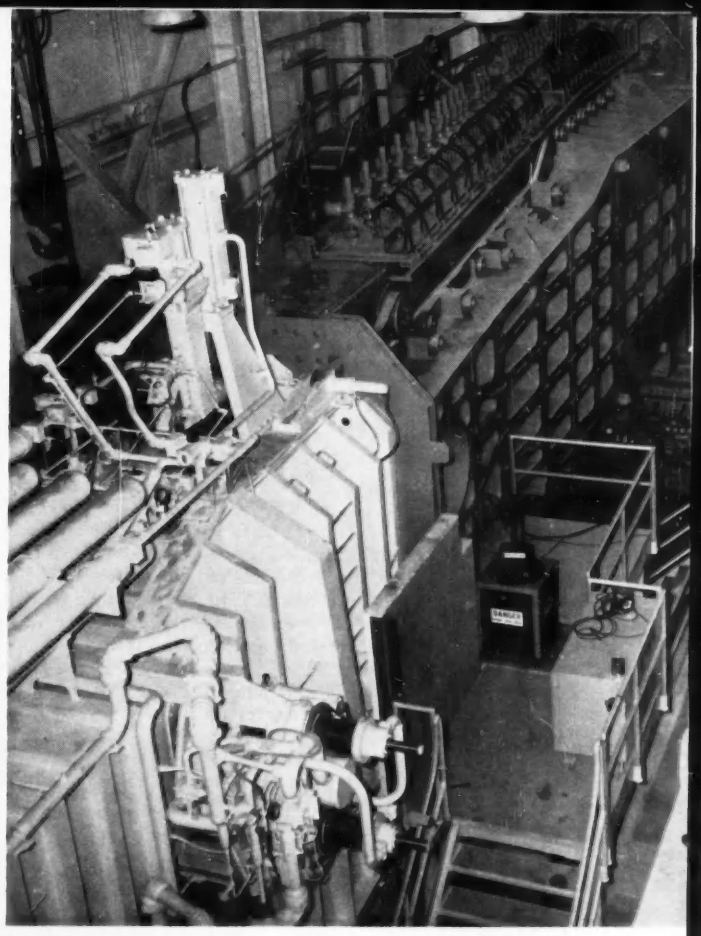
Air Systems

Each of the three tunnels at the laboratory has it own air supply, although some air from the 4-foot supersonic tunnel is required for the operation of the hypersonic unit. Supplying the 1-foot tunnel is a 150-hp nonlubricated L-type compressor operating at 125 psig. The 800-cfm compressor charges twin 4000-cubic-foot storage tanks in about 90 minutes; stabilized flow conditions in the tunnel can be maintained for periods to 40 seconds or longer depending on desired speeds. Including repressurization, model setup and positioning times, etc., an average of about three 15-second runs per hour can be made in the trisonic tunnel.

Serving the 4x4-foot supersonic tunnel is a 13,500-hp centrifugal compressor installation made up of three machines. The first-stage unit is a 6-compression-stage machine with an inlet capacity of

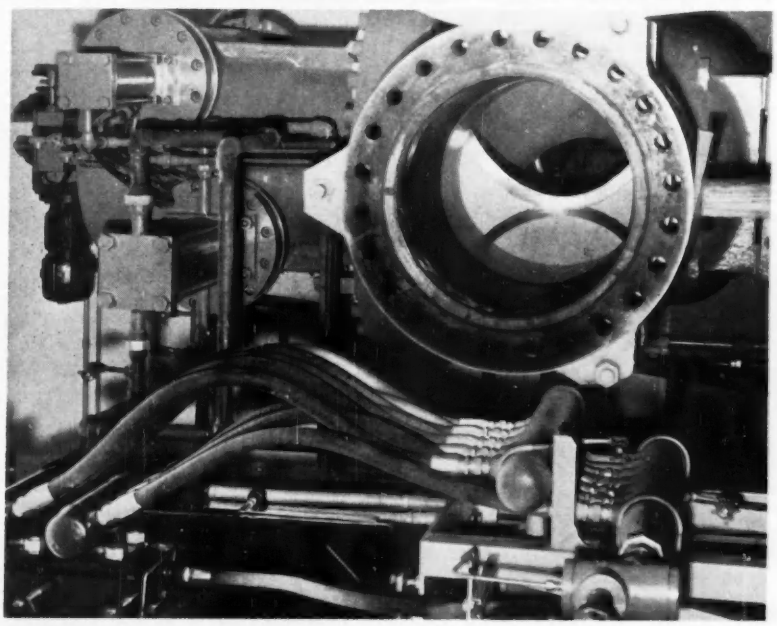






34,000 cfm at atmospheric pressure and a discharge pressure of 60 psia. It is driven at a speed of 4531 rpm by a 900-rpm, 5000-hp synchronous motor through step-up gearing. The second-stage machine is also a 6-compression-stage unit with a 9000-cfm inlet capacity. It takes suction at the first-stage discharge pressure and exhausts at 225 psia. Also a 5000-hp unit, it is driven at 8069 rpm by a 1200-rpm synchronous motor. The last stage unit is a 3500-hp 5-compression-stage unit discharging at 525 psia. With an inlet capacity of 2415 cfm, it operates at 8607 rpm and also is driven by a 1200-rpm synchronous motor. Electrical conditions for the motors are 4160 v, 3 phase, 60 cycle.

In addition to the customary blower and driver protection features, (that is, main motor interlock pressure switches on all stages and high oil-temperature feed-and-drain-line switches), Douglas has installed vibrometers on all three units. The added protection was adjudged necessary because of the rigorous operating schedule for the units. Contrary to manufacturing industry practice of running such machines for months at a stretch without shutdowns, wind tunnel operation calls for a number of starts and stops at frequent intervals. For example, the tunnel was accepted from its builders, Chicago Bridge & Iron, in July 1959.



SUPERSONIC TUNNEL The huge machinery shown at the top of the page is the Douglas 4x4-foot tunnel. The box marked "Danger" houses part of the Schlieren viewing apparatus, including some high-voltage components. At the left is a view of a Nike-Zeus missile model as mounted in the tunnel for testing. The tunnel itself can be separated in the middle, the downstream section rolling away on tracks for easy model changes. The picture that looks like a maze is exactly that—an acoustic muffler (shown during installation) that helps provide quiet uniform air flow to the test section. Above is the quick-opening (0.3 second) Roto-valve for the tunnel.

Through the remainder of that year, and to the end of August 1960, the compressors operated a total of 1094 hours. They were started and stopped 165 times during that interval, a service equivalent of many years in, say, blast furnace operation. No troubles were experienced during this time on any of the machines.

The blowers charge four storage tanks with a total capacity of 26,250 cubic feet, taking about 24 minutes to do the job starting from atmospheric pressure. The tanks then are blown down through the tunnel over a span ranging from 15–100 seconds of stabilized flow. From 3 to 8 runs per hour are possible depending on whether the storage tanks are completely dumped, or some air is retained within them.

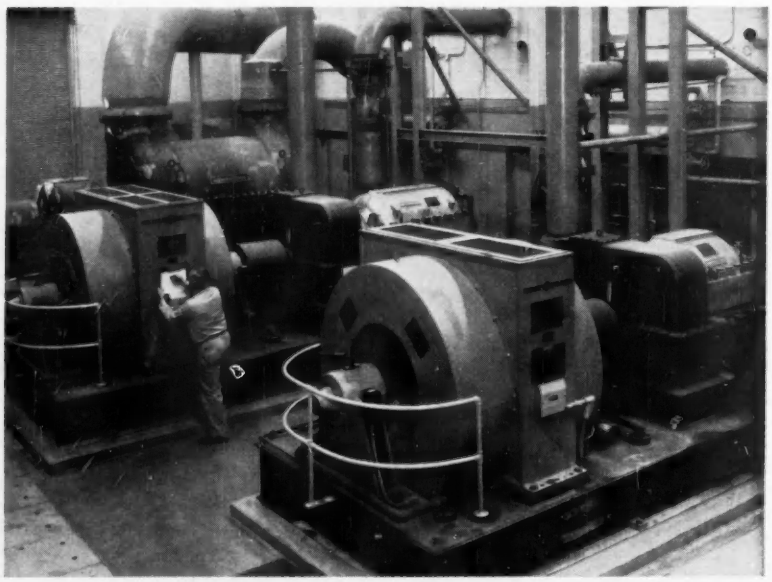
Changes in Mach numbers are accomplished by varying the nozzle dimensions of the throat by means of the flexible nozzle plates. These stainless steel plates are 0.87 inch thick, 4 feet wide and 38 feet long and are positioned by a battery of 56 hydraulic jacks. The design of the tunnel enables rapid changes in either the tunnel or model arrangements.

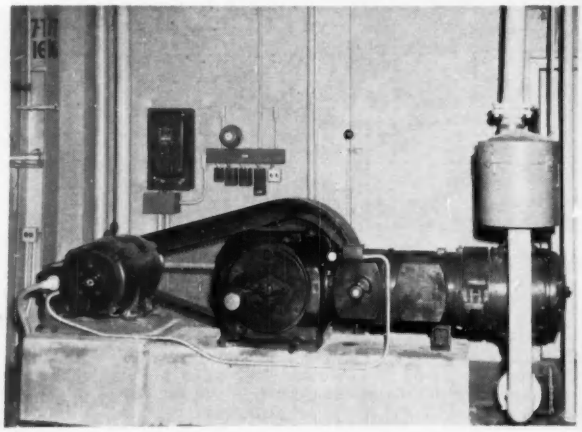
The hypersonic (2x2) tunnel is powered by a 3500-psia reciprocating compressor of 6-stage construction divided among seven cylinders. The 1000-hp machine is of the nonlubricated type to keep oil and hydrocarbons out of the air-flow system and tunnel. Air from the compressor is stored in a pair of 250-cubic-foot storage tanks and, prior to passing through the tunnel, is heated in a 10,000,000-Btu-per-hour heater to prevent liquefaction when expanding through the nozzle. An LPG standby gas supply for the heater is installed to back up the interruptible gas supply. Speeds within the tunnel are varied by interchanging nozzles, a different one being cut for each Mach number. The test section itself is evacuated prior to the start of each run and its pressure is reduced during the run by the injection of high velocity air through ejectors downstream of the variable and fixed diffusers. The ejector supply comes from the supersonic tunnel's storage tanks at 525 psia.

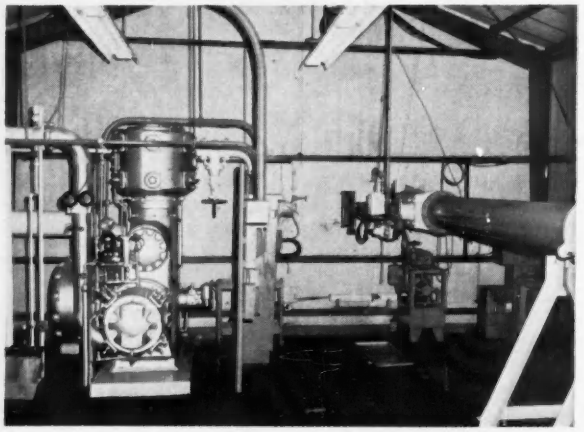
Models in the hypersonic tunnel are tested in a free jet from a suspension system in the test chamber. Provisions are made so that the models can be inserted in the jet after flow is stabilized, thus eliminating the large loads on the models inherent during start-up. The maximum run duration of the tunnel is 200 to 300 seconds and an average of two tests per hour can be run.

Data collected from the advanced instrumentation incorporated into the tunnels, model support systems and models are fed to a high-speed digital computor and an automatic data plotter to provide reduced data in both plotted and tabulated form within a few minutes after the completion of each run. Schlieren and related apparatus permit visual and photographic observation of the aerodynamic flow about the scale model during the run.

The Douglas Aerophysics Laboratory has been called the finest privately owned high-speed facility for aerodynamic testing and research in the aviation and missile industries. The multi-million dollar installation is not intended solely for space and defense research. It will also help Douglas to maintain its dominant position in the field of commercial aircraft.







COMPRESSORS At the right are the three Ingersoll-Rand centrifugal compressors that make up the supersonic tunnel air supply. From back to front, the machines are the first-stage MGA 677 6-compression stage unit; the second-stage MGA 642 6-compression stage machine; and the third-stage MGA 533 5-compression stage unit. The machines total 13,500 hp. The 3500-hp reciprocating compressor supplying the hypersonic tunnel is also in this building, but is out of view in the foreground. Below is an Ingersoll-Rand nonlubricated ESH delivering a nominal 100-psig air for plant purposes. Below, right, is the 1x1-foot trisonic tunnel air supply—an Ingersoll-Rand 150-hp XLE-NL compressor. The 2-stage machine is rated at 125 psig.

Drilling Begins on Project Mohole

WORK will begin this month on an experimental program to test equipment and techniques for possible use in deep, offshore drilling through the earth's crust down into the mantle. A site for the operation has been chosen near Guadalupe Island off the western coast of Mexico in some 12,000 feet of water.

The name of the project to drill a series of holes is the "Mohole." Between the earth's crust and the mantle is a boundary known as the Mohorovicic discontinuity, after a Yugoslav seismologist whose studies of earthquake waves first indicated the boundary's existence. Scientists refer to the boundary as the Moho. Calling the proposed bore the Mohole followed naturally.

The contract for the test drilling has been awarded by the National Science Foundation, a federal agency, to Global Marine Exploration Company, Los Angeles, Calif. Technical direction and scientific guidance will be provided by the AMSOC Committee of the National Academy of Sciences and the National Research Council, a private organization of scientists and engineers.

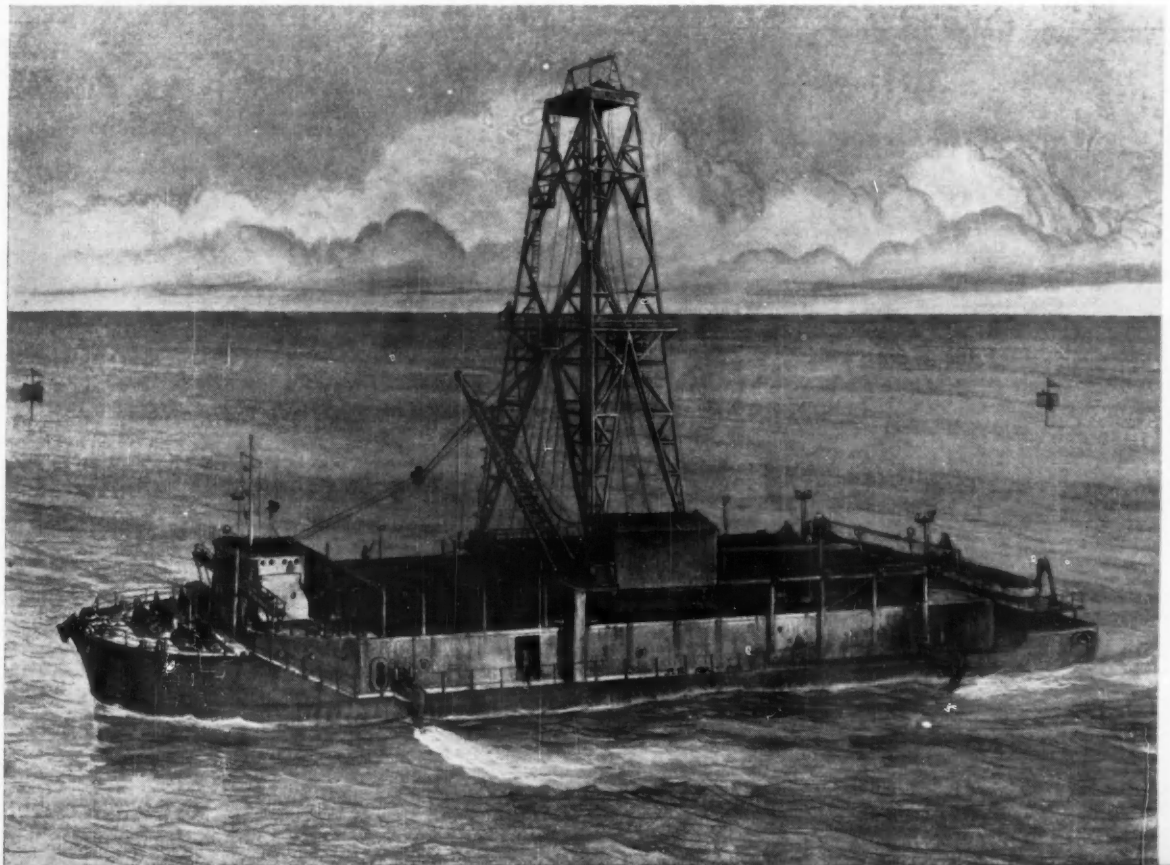
To find a suitable place to drill, seismic studies of the ocean floor were made during the summer of 1960 in the Caribbean and off the coast of Southern California and Mexico. Offshore drilling will be necessary for this reason: the earth's continental crust has an average thickness of about 20 miles, but the suboceanic crust may occasionally be as thin as $2^1/_2$ miles. If man is to punch through the crust, the ocean floor appears to be the only feasible place to do it. Actual drilling of the Mohole will depend upon the outcome of the experimental work, subsequent engineering and design studies, and site surveys. It is not expected to begin for several years.

Plans for such an undertaking have been in progress for some time. Strangely enough, the project, which may eventually unlock some of the earth's most fascinating secrets, evolved partly from a good-natured reproach of scientific organizations and their penchant for many-initialed and intensely-specialized committees.

Harry Hess, professor of geology at Princeton University, and Walter Munk, professor of oceanography at the University of California, first thought of drilling the Mohole and suggested that the task of putting down the bore be made a project of AMSOC. Here is where the reproach entered in. The initials stand for American Miscellaneous Society. The group, formed in 1952, has no officers, constitution, bylaws, publications and no roll of members. Inclined toward geophysics, it is stubbornly informal and its casual organization permits business to be conducted with unique dispatch. For example, the society has met in Washington, D. C., at cocktail time with a 2-member quorum.

Five of the original nine members of AMSOC's deep drilling committee were members of the National Academy of

CUSS I **This drawing shows the drill vessel as it will appear at the site near Guadalupe Island. Astride the 260-foot, 3000-ton converted freight barge stands the tall drill tower, while the bulk of the deck stores horizontally-racked drill pipe. The ship's position will be held by a pilot controlling large outboard propellers at the four "corners" of the vessel. Two props can be seen swirling here on the visible side. Sonar signals bounced off several submerged buoys surrounding the ship will tell the pilot whether the craft is over the hole. Buoy markers are visible at left and right.**



Sciences. As interest in the Mohole project was generated, it was not difficult for the group to become a formal committee of the Academy. This allowed it to be eligible for funds from the National Science Foundation. Gordon Lill was named chairman of the committee.

Why should earth scientists be interested in probing far down into the earth? What can be learned?

Many things. Geophysicists know indirectly that the earth's crust consists of two main materials. The continents are sheets of relatively thick, lightweight granite. Between continents—in the ocean basins—lie large areas of thin, denser basalt. Below both rests the denser matter of the mantle on which the crust "floats" in equilibrium. It is believed that the mantle is composed largely of an igneous mineral called peridotite. Extending down to a depth of about 3000 miles, the mantle accounts for about 84 per cent of the earth's volume. Below the mantle is a core of about 850-mile radius, thought to be nickel-iron material.

At present there are divergent theories explaining the physical action that went into the earth's formation, the forces that produced the crust, mantle and core arrangement. There is, however, no direct information about the materials of the interior and about distribution of radioactivity with depth (which is related to heat). The Mohole will provide a window that geophysicists may peer through to learn about the earth and its beginnings. Perhaps evidence can be found to substantiate one of the several theories, or refute them all.

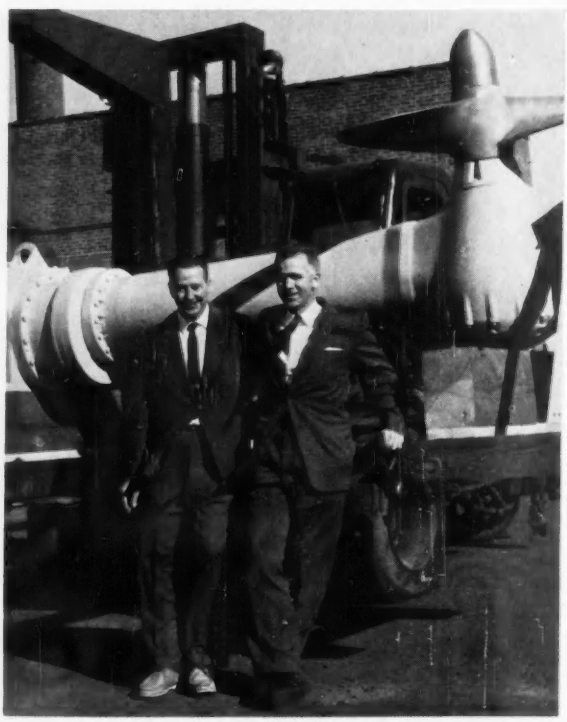
There are other reasons to plumb our planet's interior. The orientation of oceanic sediments in general is far different from the often highly convoluted position of land strata. Many deposits of the ocean bottom probably have never been disturbed. Unlike land formations we have investigated, there may be places where deposition has been continuous since life's origin. Through fossils we have gained a reasonable picture of life since the Cambrian period but there are no fossil-bearing rocks on land to tell us what lived earlier. With the exception of the vertebrates (the most advanced), all phyla are recorded in the Cambrian, so it seems apparent that much of the early evolutionary sequence has not yet been examined. The Mohole may make this possible. Even more fascinating is that far, far down under the quietly-laid ocean sediments must be the material that represents the primordial surface of the earth—the raw face of the planet.

Yet as Willard Bascom,* project director of the Mohole operation, has said, possibly the most important object is to search for the unexpected: "The history of science has repeatedly demonstrated that unpredicted discoveries which upset accepted theories are the most valuable result of new work." Besides unearthing sediments, the Mohole will almost certainly tunnel also into the foundations of many scientific beliefs.

Bascom points out that the entire project will probably cost at least $15,000,000. This amount is respectable but certainly not staggering in this day when a single missile launching can run in the millions. "It seems," he says, "a little foolish to go off to look at the moon when we do not know what lies a few kilometers beneath us on our own planet." Indeed, one reason for the initial suggestion of sinking a Mohole was the need for a geophysical analogue to the space program.

The $735,750 project contract starting this month calls for modification of Global Marine Exploration Company's 260-foot drilling ship, *Cuss I*, and the use of the vessel throughout the drilling, expected to take about a month. If the first hole is successful, others may be drilled to obtain operating and scien-

* Mr. Bascom's book about Project Mohole, *A Hole in the Bottom of the Sea*, will be published in May by Doubleday & Company.



DIRECTOR At right is Willard Bascom, director of Project Mohole, with Roger Taggart, the naval architect who designed "Cuss I's" four propeller controls. On the truck is one of the huge props that will keep the ship positioned.

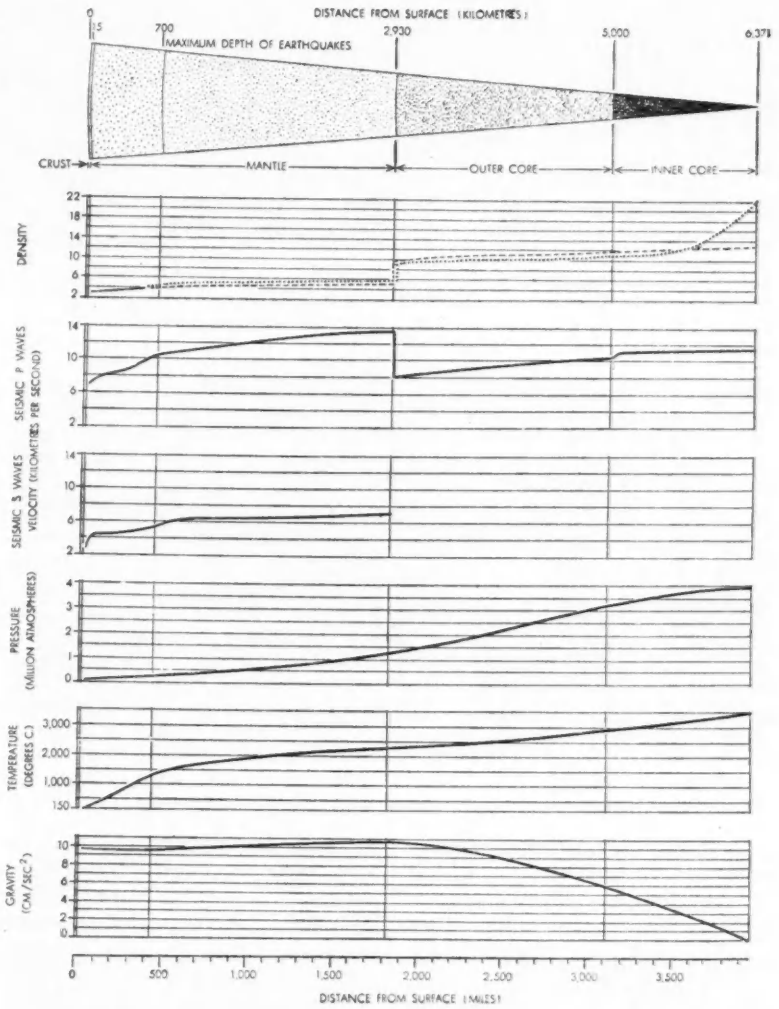
tific data for further planning of Project Mohole. Nearly all previous offshore drilling has been done in water less than 100 feet deep with the drill platform standing on the ocean bottom. One anchored vessel has worked in water 400 feet deep and penetrated as far as 10,000 feet. But these operations were vastly different from Project Mohole in that they were anchored. In the current tests, drilling will be carried out from an unmoored ship holding its position by means of four large outboard motors, in water some 30 times deeper than the 400-foot depth.

Site for the experimental work is in the vicinity of latitude 29° N, longitude 117° 30′ W. Sampling and sonic surveys have indicated that the first 500 feet of ocean bottom in the area consists of unconsolidated soft sediments with a hard layer below. Drilling will be attempted by the standard rotary method used on land by the petroleum industry. The main objectives will be to confirm the elaborate engineering computations of the stresses acting on the ship and the drill pipe, and to determine optimum drill pipe rotation speed and the necessary amount of weight on the bit. All holes will uncased, that is, the only connection between the ship and the sea floor will be the drill pipe itself. This means that once a bit has been withdrawn from the hole, the hole cannot be re-entered. Therefore, all sampling and measuring operations must be conducted by lowering tools and instruments through the drill pipe on a cable or wire line. Diamond bits will be used.

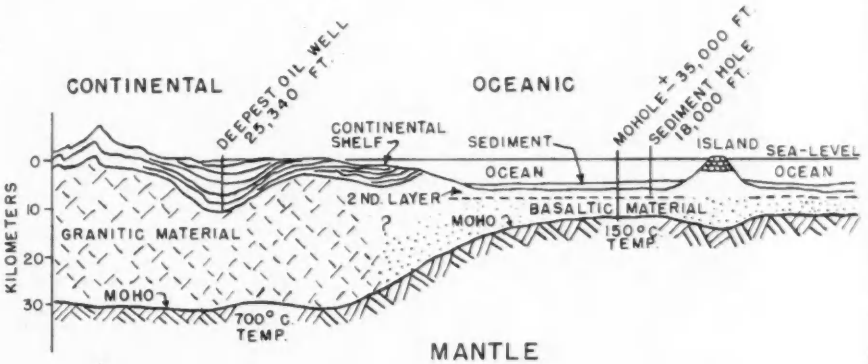
Depending on the success of the drilling and depths reached, experiments will be conducted to record the physical properties of the sediments that have been penetrated. Data will be sought on electrical and heat conductivity; seismic velocity (speed at which rock conducts seismic waves); and earth magnetism and gravity.

Feasibility studies conducted by the AMSOC Committee with the National Science Foundation's support have indicated that *Cuss I* will be able to maintain position with the use of four diesel steering motors mounted at the corners of the ship. The vessel's position will be determined in relation to a ring of four or five buoys anchored to the bottom and held several hundred feet below the surface by taut lines.

The buoys will be equipped with sonar transponders ("pingers" using the same principle as sonar submarine-detecting devices) that respond to sound waves sent through the water by the ship in the middle of the circle. Electronic equipment on the vessel will translate the echos from the buoys into distance, and present this information to the pilot. He then will maintain position over the hole by regulating the steering motors.



EARTH'S INTERIOR At the top is a wedge-shaped section that shows thicknesses of the earth's inner layers. These were arrived at indirectly by taking seismic readings and noting other characteristics, shown in the lower curves. A Mohole will allow direct examination of the crust and uppermost mantle.



EARTH'S CRUST This schematic drawing illustrates the advantage of drilling a Mohole through the sea floor. A similar bore on land would have to be about 100,000 feet deep—or four times the penetration of the deepest oil well. The water depth at the selected drilling site near Guadalupe Island is some 12,000 feet; the mantle is probably about 20,000 feet farther down.

Volca-Rock

The Stone of Lightness and Strength

IN TALKING about the sense of lightness, Edward Stone said, ". . . concrete in the past had always been regarded as a material of great weight and bulk, and 50 years ago no one could have conceived of the diaphanous roof structures of today. Light shell-like concrete buildings, some only a few inches thick, now span enormous rooms measuring hundreds of feet in diameter." Though talking about buildings for which he is now famed, the architect was also summarizing man's age-old search for a lightweight material to lessen the weight and cost of structures.

It was more than 2000 years ago when the Chinese discovered the art of expanding certain rocks with heat. Most rocks contain water of crystallization. When subjected to intense heat, the water is converted to steam, expanding the rock like popcorn, often as much as eight times its original bulk, and lowering its density. This material is called perlite and has been found useful for many purposes. It is lightweight, but unfortunately has little strength. Perlite is, in effect, as sleazy as pumice processed from volcanic ash and lava flows.

In man's continuing search for strong lightweight materials, an unusual mountain was discovered. The restless earth rumbled millions of years ago and a volcano was born in the middle of the Mojave Desert near the present town of Bagdad, Calif. It was a time when major physical changes were taking place throughout the world—when the Alps, the Caucasus and the Himalayas were heaved up.

Most volcanos—take for example Vesuvius, the burier of Pompeii—most volcanos build up a conical crater and release rivers of lava that cool slowly into layers of hard, dense twisted black lava and scoria, covered with beds of windblown ash. The yield is hard basaltic lavas for building stone, and ash for pumice. The latter, being completely burned out, is light in weight but has no strength of its own. Though most commonly thought of as an abrasive, pumice has also been added to cement for construction work. Early examples are found in the pozzolan cement of ancient Roman walls, aqueducts and harbor works; the volcanic debris came from Vesuvius.

The Bagdad volcano's formation was different. Today's desert was then a Tertiary inland sea and the volcano cooled immediately into its present shape. In time the lake subsided leaving the crater standing high over the surrounding wasteland—an unnamed sterile mountain of rock that looks much like sponge rubber with its myriads of small holes. The texture belies the rock's hardness—its toughness. The mountain stands in its quick-frozen state, resisting erosion and vegetation.

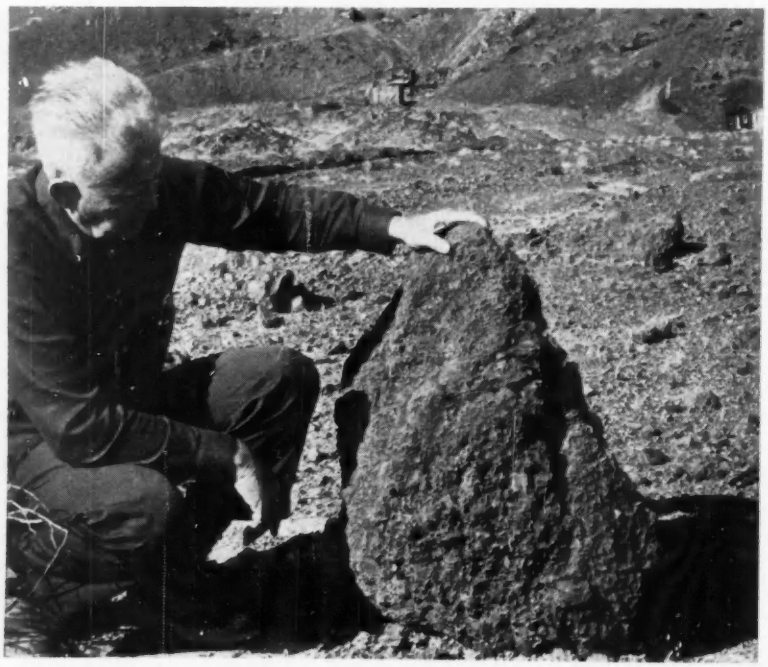
The property was acquired by Volca Rock Company in 1950, and tests were made to determine the chemical analysis of the lava. These were the results:

Silica	42.40%
Iron Oxide	8.96
Alumina	20.84
Calcium Oxide	9.00
Magnesium Oxide	8.99
Sulphur Trioxide	0.48
Chloride	0.02
Sodium Oxide	2.70
Potassium Oxide	1.54
Moisture	0.60
Loss on Ignition (not incl. moisture)	4.24
Boron	Trace

The stone was ground into small particles and sharp sand for use in acoustic plasters and plaster specialities. The lightweight concrete blocks made with the Volca additive meant that for the first time contractors had lightness with strength.

Because of the porous nature of each particle of this ground rock, enough water is held in a plaster mix to permit workers to make special effects that simulate various textures. Early use for these plaster specialities was at Disneyland. Structures that appear to have brick and stone fronts and towers are, in reality, made of Volca plaster scored to look like the real construction materials.

Like most young organizations, all was not smooth going for Volca Rock Company. Take the matter of obtaining the rock. At first it was drilled, then blasted with 25-percent nitroglycerin. This proved unsatisfactory because of the porosity of the rock and the consequent dissipation of the expanding gases. Later the material was mined with a bulldozer and ripper, but the extreme toughness was more than small-sized crushers and rolls could handle. Wear and breakage proved costly. Drilling



VOLCA-ROCK In the foreground, a piece of float. Although looking like a sponge, Volca-Rock has great strength as well as light weight.

large-diameter holes and blasting with nitrogen prills or slow powder to break large faces of the talus ahead of crushing and classifying machinery seems to be the best method of attack at the present.

Even the development of a new market was beyond the scope of the infant concern. Two factors were working against it. First was the high cost of production. The rock was not competitive. There was a general expression of satisfaction with other lightweight aggregates made by industry at large. Second, there was no real need for materials resistive to intense heat.

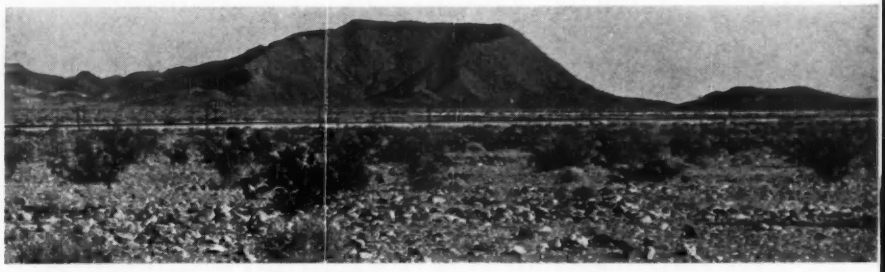
Then missiles came into their own. Test stands were required for the jet engines. Launching pads and silos were needed. Warm-up revetments for jet aircraft had to be constructed, and heat-resisting runway surfaces for airports had to be laid. As in the expanding of perlite, the aggregate in ordinary concrete would expand with the concentrated heat, popping and spalling, demolishing the installation with each engine test.

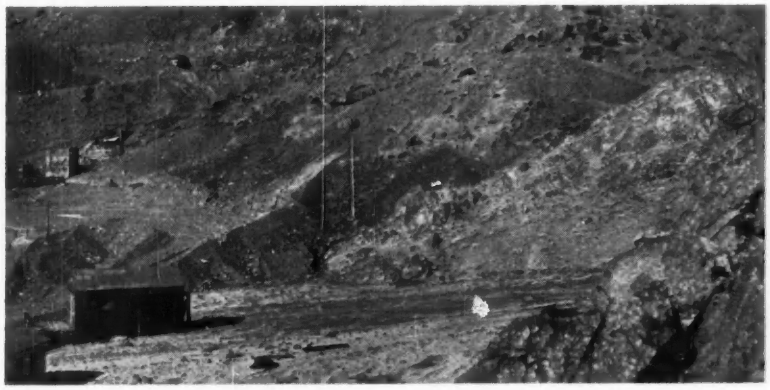
A search was made for new materials to withstand this high heat. Many were examined, including carborundum, emery, crushed fire brick and some new synthetics. All were expensive and none really satisfactory. Some that could withstand the high temperatures had poor insulating properties. The heat was transmitted through the protective surface, weakening the substructures.

Volca-Rock, the aggregates from the Bagdad volcano, meets all the requirements. This material has been "clinkered" by Nature, just as limestone and shales are clinkered in the kilns of cement manufacturers. Because of the many small holes, it has excellent insulating qualities. Compared to other high-heat-resisting materials, Volca-Rock is relatively inexpensive.

A piece of Volca-Rock $1^1/_2$ inches thick may be held in the hand while applying the 6000° F blast of an acetylene cutting torch until the top side is fused to a depth of $^1/_2$ inch before the rock is even warm on the underside. Cast concrete test patterns of Volca-Rock aggregates with Volca sand cemented with high-temperature alumina, in a checkerboard of samples made with other types of temperature-resisting aggregates, show that Volca concrete withstands the high temperature blasts, as from jet engines, with only one-half the burn down (ceramitization) of comparative test pads made from materials costing ten times as much.

As a result of this high-hea- resistance and low coefficient of heat transfer (the K-factor), the construction industry also is turning to it for precast furnace linings and steel mill floor surfacing, industrial chimney linings, and high-temperature blocks and shapes for all types of boiler installations. The second problem prohibiting the expansion of Volca Rock





BAGDAD VOLCANO The view below is to the northwest. In foreground can be seen bunk houses and to the left center, screening equipment. Above is a view to the east, taken from Siberia, about 3 miles away. It shows the slope with its blown out crater.

Company seems to be considerably lessened. Sales are now being handled by Designed Concretes Company, which produces sacked mixtures. Velvatone Stucco Products Company, Inc., Los Angeles, Calif., which owns one-half the stock in Volca Rock Company, is searching for additional capital to put the mine into full operation.

Concerning the first factor that worked against the young company—the competitiveness of Volca-Rock with other lightweight aggregates—additives can be compared with prosaic concrete using crushed granite or trap rock and river sand aggregates.

Aggregates	Conventional	Volca-Rock
Weight lbs/cu.ft.	165	93.5
Compression Resistance (psi)	4000–5000	7900
Tensile Strength (psi)	450–500	1100

In other words, it can be said that although Volca concrete is about one-half the weight of ordinary concrete, it has a 57-percent-greater compressive strength and a 120-percent-greater tensile strength. In addition, the cost is only about 10-percent more.

What does this mean to industrial contractors? Concrete with Volca additives can be used for skyscrapers, lessening the cost of the structures by providing lighter-than-steel concrete bridge beams. Prestressed beams cast with Volca concrete can be in the shape of a tee for bridges and highway overpasses, so that when installed with the top bars of the tee's placed together, they form the roadbed. This eliminates expensive forming and casting of a concrete roadbed over supporting steel beams. Only surfacing with lightweight Volca concrete and the attachment of railings and trim are required to complete a job, saving considerable time.

Where construction specifications do not require high strength, as in roof decks, floors and tilt-up slabs and precast veneer stone, the Volca concrete mix may be further lightened by the admix of perlite. This reduces the strength of the concrete to only 4000–5000 pounds per square inch, with a corresponding weight reduction to 55–60 pounds per cubic foot—a concrete that will float on water.

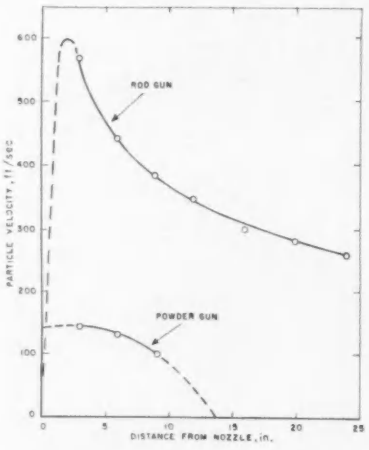
In connection with the recently developed techniques of prestressing concrete beams, with tilt-up and raised floor construction, the light weight of Volca concrete offers the added advantage of reducing transportation, lifting and labor costs. It may be said that like many of Nature's treasures, the potential economic uses of Volca-Rock have not been fully explored, even though it has existed for millions of years.

The Advantages of Air Pressure in—

Flame-Spraying of Alumina

THE BASIC principles involved in flame-spraying processes for coating metals with alumina are being investigated by the U. S. National Bureau of Standards for the U. S. Air Force. Potential uses of the heat-resistant coating thus produced include the thermal protection of jet and rocket engine components, and regulation of temperature within space vehicles. Although the coating of parts by flame-spraying has been practiced for many years, the application of alumina by this means is relatively new.

Of the three current methods of applying coatings to metal by particle impact —that is, flame-spraying, detonation and plasma-jet—the first technique offers the advantages of mobility and relative ease of operation. In flame-spraying alumina, two types of oxy-acetylene guns known as the "powder gun" and the "rod gun" are used to melt and propel the particles. In the first, finely divided alumina is fed into the combustion zone, producing a continuous stream of particles. The rod gun is fed by a $^1/_8$-inch rod of sintered alumina, and air is introduced at the exit nozzle to increase particle acceleration. It was observed that the rod gun normally produced bursts of particles, rather than a stream.

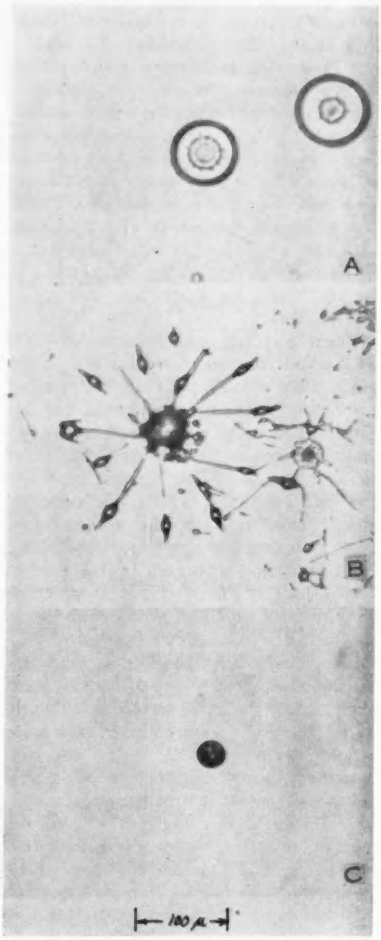


VELOCITY Curve showing average particle velocity at increasing distances from the guns. High-pressure air is forced into the rod gun, giving the particles a higher velocity than that produced by the powder gun.

Surface Roughness

The experiments have shown that the strength of the bond formed between alumina and iron increases exponentially with an increase in the part-to-be-covered's surface roughness. To measure bond strengths, metal strips were roughened to various degrees by different blasting treatments. These pieces were then mounted between two knife edges so that a 0.05-inch length of each strip projected beyond the tips. Both sides of this projecting portion were spray-coated to a thickness of 0.100 inch, ±0.002. The force required to shear the coating from the strip was then determined by pulling the coated section through the gap between the knife edges.

It was found that the sprayed particles of alumina did not adhere to metal strips that had been polished. The measured bond strengths for surfaces that had undergone severe roughening were many times greater than those for surfaces that had received only mild roughening treatment. Furthermore, bond strengths for coatings formed with the rod gun were greater than for those formed with the powder gun.



MELTING The appearance of alumina particles collected at various distances from the flame-sprayed guns is an indication of their condition at time of impact. In photo A, the particles were molten only on the outside; the gun was a distance of 2 inches from the glass slide. In photo B, the slide and nozzle were 4 inches apart and the particles were completely molten. At 6 inches, photo C, the particle shows a molten core surrounded by a solid envelope.

Disk Velocimeter

A rotating disk velocimeter was developed for determination of particle velocities. This device (*see drawing*) consists of a 16-inch metal disk, with a narrow metal strip attached by posts that support it at a known distance from the surface of the disk. A glass slide is attached to the disk so that it is partially shielded from the sprayed particles by the narrow metal strip.

When this slide is sprayed with the molten alumina, the strip creates a "shadow" in the layer of particles that

adhere to the slide. The slide is first sprayed while the disk is at rest, then when it is rotating at a known speed. The displacement between the two shadows thus formed on the slide is a function of the particle velocity. It was found that the particles from the rod gun had a measured peak velocity of 566 feet per second, as a result of high-pressure air forced into the gun; those from the powder gun achieved a 145-foot-per-second velocity (*see graph*).

Particle Temperature

No direct method was devised for determining the temperature of the small, fast-moving particles; however, the appearance of the particles after impact did give an indication of their consistency at the instant of contact. To do this, glass slides were held at various distances from the guns. Then they were sprayed, and the particles that adhered were examined microscopically.

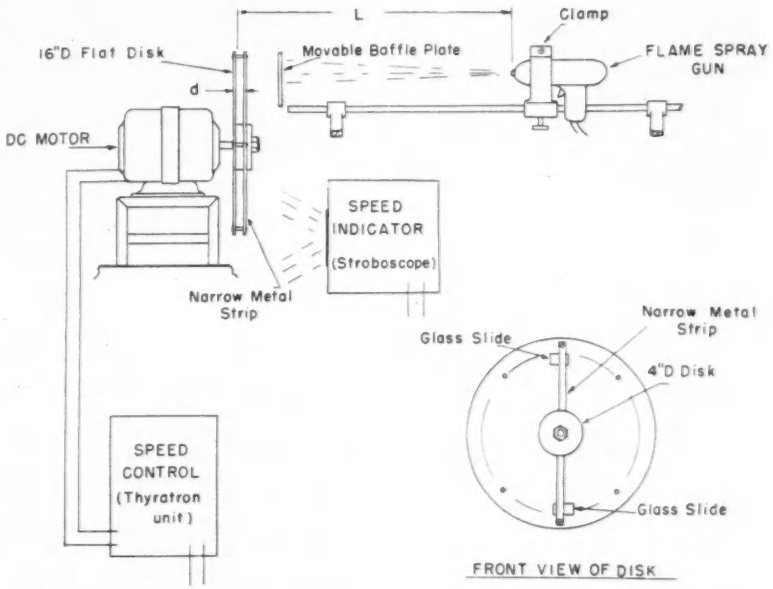
From the patterns produced by the particles when they deformed upon impact, it was determined that at 2 inches from the powder gun, most of the particles were molten only on the outside (*see photo A*). At 4 inches practically all of the droplets were completely molten (*photo B*); whereas at 6 inches, only the cores were molten (*photo C*). Particles that are completely molten at the time of impact adhered more readily than the others. The rod gun particles, again because of their high-air-pressure-induced velocity, flowed more on impact than did the powder gun particles.

Cooling Characteristics

The thermal properties of a material influence the flow of molten particles immediately following impact. When the adhering particles cool more slowly, as they do on glass, flow continued for a longer time than when the cooling rate is very rapid, as it is on platinum.

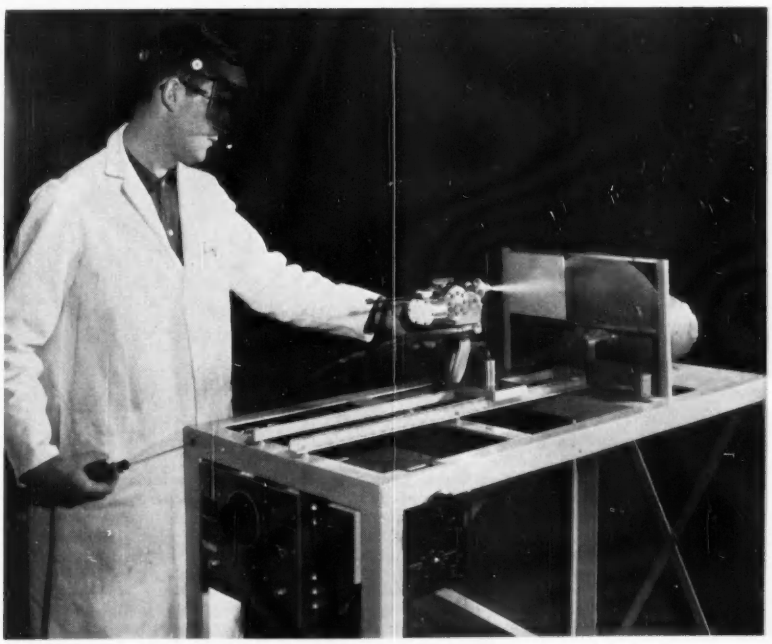
When a particle strikes glass it cools more rapidly than when it strikes metal, allowing more time for a chemical bond to form. To indicate whether slower cooling would also give a chemical bond with metal, augmenting the mechanical bond, a strip of iron was coated with porcelain enamel, which in turn was covered with a 0.0003-inch layer of nickel. The ceramic substrate effectively lowered the cooling rate of the sprayed particles, but the bonding was not improved.

On glass, good bonding occurred whether the surface was rough or smooth, but on iron the bond strength was substantially increased by roughening the surface. These results suggested that the bond between the alumina coating and glass substrate is largely chemical, whereas the bond formed between flame-sprayed alumina and metals is principally mechanical in nature.



ROTATING DISK Schematic drawing of the rotating disk velocimeter developed at the National Bureau of Standards. The baffle plate is removed after the particle stream is adjusted. The disk is sprayed at rest and again when rotating at known speed, and the offset of the shadows cast by the narrow metal strip is a function of the particle velocity.

EXPERIMENTING Molten alumina particles are directed against a rotating disk velocimeter from an oxy-acetylene gun. The flame-sprayed alumina can be used to protect parts used in jet and rocket engines.



This and That

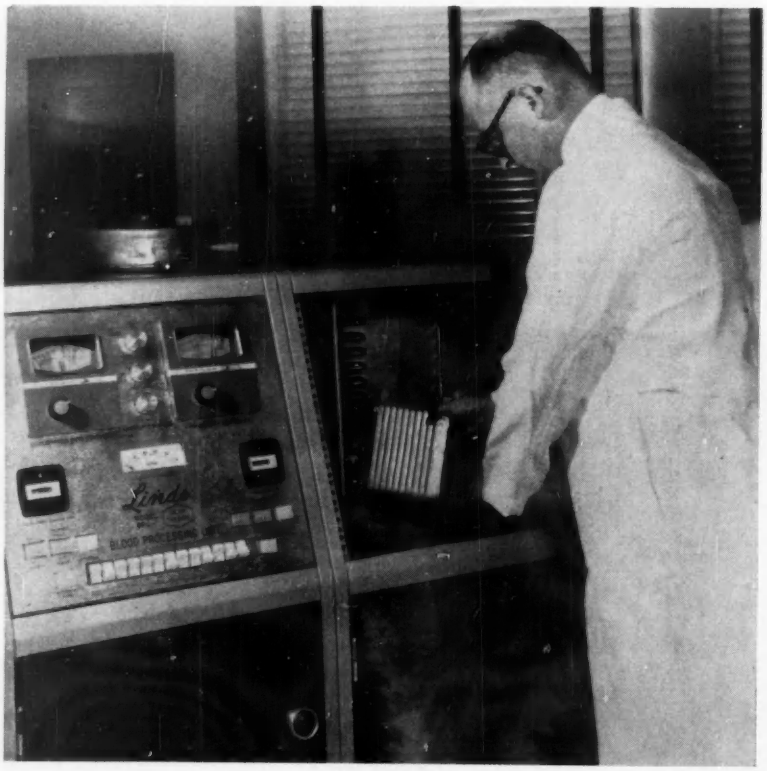
Pressures Of The 20th Century

Diamonds have been "grown" from graphite under a pressure of 85,000 atmospheres (1,249,500 psi) and at a temperature of 1600° C, using nickel as a catalyst. Such a pressure seems astounding, yet even greater ones have been achieved. They were reported by William G. Field, chief of the Crystal Growth Section, Air Force Electronic Material Science Laboratory, Hanscom Field, Bedford, Mass.

Using a 600-ton tetrahedral-anvil press, ultra-high pressure of 125,000 bars (2,000,000 psi) has been reached in conjunction with temperatures in excess of 3000° C. High pressure has been available for some time but heretofore the usefulness of it has been limited by the temperature range which could be utilized. New equipment not only produces very high pressure, but permits in addition the simultaneous application of temperatures in excess of 3000° C.

Of what use are such pressures other than leading to a marked increase in understanding of the solid state? Ultra-high pressure, a form of mechanical energy, can change the properties of matter to a great extent. It can also affect the possibility and speed of various reactions.

For example, when solid materials with a definite crystal structure are subjected to high pressure, it is possible to force the atoms in the material into new atomic arrangements. In some materials, such as bismuth, as many as eight different atomic arrangements can be produced. When the most compact arrangement has finally been obtained, the atom itself can be deformed. In this case it is possible to free electrons from the atom and produce such strange effects as to change a nonconductor into a material that behaves like a metallic conductor.



Linde Company, a division of Union Carbide Corporation, is developing a method to indefinitely store whole blood (not plasma) by freezing with supercold gases. The photograph shows a technician placing a whole-blood packet into a unit containing liquid nitrogen at –320° F. When perfected such a system will solve a problem that now confronts hospitals: a patient with a rare blood type occasionally needs blood urgently, but none is on hand since it can't be stored. Through newspapers, radio and TV, the hospitals must appeal for donors. The hospitals can never be sure the right type of blood can be obtained as quickly as needed. Also at Linde, research is underway to cryogenically preserve bone marrow and perishable human tissues.

★ ★ ★

Rex 49, A High-Speed Steel

Crucible Steel Company of America has developed a new grade of high-speed steel to provide increased tool life in machining hard-to-cut metals. It is undergoing exhaustive evaluation in production use to confirm preliminary laboratory and field tests. Rex 49 may prove to be the best composition for tools designed to cut such materials as highly alloyed steels at high hardness levels, stainless steels, super alloys and titanium. It can be heat-treated to 67 to 69 Rockwell C, and in performance tests has increased tool life two to four times. Rex 49 is even reported to be outperforming the more expensive high cobalt and high-vanadium steels—cost is only $2.07 per pound—and it is expected to eliminate the need for many of the more than twenty special-purpose grades now in use. With normal materials, Rex 49 means increases in speed, feed and depth of cut.

★ ★ ★

Easy High Vacuum

The American Physical Society's recent West Coast meeting heard a report by Lawrence Radiation Laboratory personnel on a method for achieving ultrahigh vacuums without system bake-out. Molybdenum is the secret. After a vacuum system has reached about 10^{-7} mm Hg by standard procedures, the molybdenum is introduced as a "getter" and continuously evaporated from simple, hairpin-type filaments. The vacuum is then brought down to below 10^{-9} mm and stays there. In a container of 85-liter capacity during one test, only 0.3 gram of the metal was needed to hold the vacuum at this high level for 40 hours.

Bottles On The Foam

Thirty-six thousand bottles floating on the ocean for some three years have provided the Pacific Oceanographic Group of the Fisheries Research Board of Canada with confirmation of the circulation of the Northeastern Pacific and the Bering Sea. Starting in August 1956, the bottles were released at intervals in various locations by the board's scientists, and the returns, which averaged 5 percent, have been analyzed at the Group's headquarters. The pattern of circulation shows the seasonal and annual variation of circulation: a 2-mile-per-day midocean movement towards North America; a division near the coast into northward and southward flows; a movement of the northern flow around the Gulf of Alaska (the Alaskan Byral) and along, through and around the Aleutian Islands into the Bering seas with some return movement south of the Aleutians.

★ ★ ★

Trans-Pyrenees Tunnel?

As the French and Italians progress with the tunnel through Mont Blanc, Spain has suggested that she and France blast a vehicular bore through the Pyrenees. According to a story in the *New York Times,* the proposed tunnel would be about $1\frac{1}{2}$ miles long and 3800 feet above sea level. It would link the village of Benasque in Huesca Province, Spain, with Luchon, a resort town in France's Haute-Garonne Department. Approximately halfway between the Atlantic and the Mediterranean among the Pyrenees, the bore would pass through the 6995-foot peak known as Pic de la Glere. Spain has approved a plan that calls for spending $1,000,000 and about a third of this has been drawn by construction concerns that are building a 6-mile mountain highway from Benasque to the tunnel heading. The Spanish portal lies at 3900 feet elevation. On the French side, a 4-mile access road will be needed to reach the tunnel face and French approval of the plan is expected. The tunnel would reduce the driving distance between Luchon and Benasque from 100 to 17 miles. The 290-mile trip from Toulouse to Saragossa would be 100 miles less.

Representatives of the two countries met in Benasque last November to discuss the project. Spanish delegates said their country would not be able to accept a French proposal for a panoramic highway over the Pyrenees. Military reasons dictated that the link must be a tunnel. The Spanish reportedly made clear that they regarded the proposed tunnel as an economic advantage rather than an aid to motorists. First feelings from France have been favorable. Shortly after the meeting, the Haute-Garonne Prefecture at Toulouse was informed by the Ministry of Public Works that the spring conference of the French-Spanish Commission of the Pyrenees had put the Luchon-Benasque Tunnel on its agenda.

★ ★ ★

Surveyor To The Moon

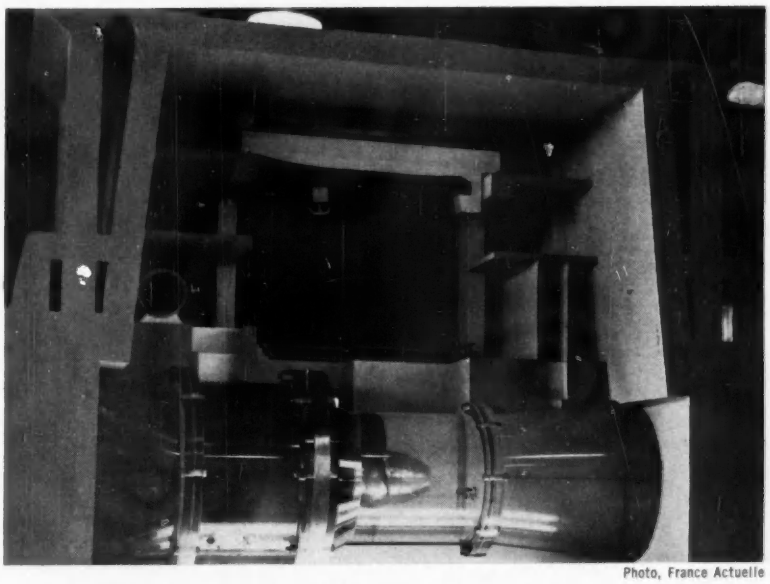
The National Aeronautics and Space Administration (NASA) has selected Hughes Aircraft Company for contract negotiation on plans to build a soft-landing lunar spacecraft called Surveyor. The spacecraft will be designed to land gently on the moon, perform chemical analyses of the lunar surface and subsurface and relay back to Earth television pictures of lunar features. Plans call for seven Surveyors to be launched in the period 1963–65. The lunar landing will be accomplished by a solid propellant rocket charge which will fire in a direction opposite to the flight of the spacecraft to slow it down to about 10 mph. This is slightly slower than a manned parachute landing on Earth. The craft will stand on three legs and project upwards about 11 feet including its directional antenna.

Surveyor will be fired with the Atlas-Centaur from Cape Canaveral, Fla., and will weigh 2500 pounds at launch. When it completes the lunar landing after about 66 hours in space, it will weigh 750 pounds (earth gravity), the lost weight having been fuel. About 500 pounds of the landed weight will be communications equipment, temperature control instrumentation and structure. The remaining 250 pounds will be scientific instruments (including television cameras) and a drill that will penetrate at least 18 inches of the lunar soil and draw cuttings into the craft for chemical analysis.

★ ★ ★

On The Land, On The Sea, And In The Air

Until recently, it was thought impracticable to have a single vessel that could operate as a submarine, a surface vehicle or an aircraft, depending on the operator's whim. That is exactly what Robert W. Pinnes has developed, although it is still on paper. His invention can travel over land or sea on a cushion of air, drawing the air through a duct at the top and forcing it down through a circular jet against the surface over which it is moving. When the operator wants to submerge, the duct-fan mechanism is stopped, a water tank is opened, and power is shifted to a propeller. To raise again, the water tank is simply emptied. This amphibious ground-effect machine offers great maneuverability as well as the hidden-attack advantages of submersibles.



Photo, France Actuelle

As needs for power expand, engineers continue to look longingly at the millions of horsepower that are wasted with each flow and ebb of the tides. At St. Malo, France, they are doing something about it. The picture shows a model of a hydroelectric generator installed there. It works as a turbogenerator between a storage basin and the sea, in either direction of flow. It also serves as an electro-pump in both directions, allowing for preparation of peak-load periods. Two other advantages of the unit are its ability to store power when demand is slack and its low construction expense compared with conventional turbogenerator units. Built by AC Division of General Motors, the equipment was developed by Alsthom, Jeumont and Neyrpic companies.

Attacking Ice to Save Fish and Fowl

Paul Ziemke and Eleanor Jones

BUBBLES KEEP AREAS SUCH AS THIS ONEIDA COUNTY, WIS., TROUT POND FROM FREEZING OVER AND SUFFOCATING FISH.

LAST year this magazine described certain "bubble curtain" techniques employed in commercial fishing for herring (see "Air Angling," June 1960). Ironically, similar equipment is being used in icy fresh waters to save rather than capture fish.

Conservationists have known for some time that many fish suffocate during the winter because their oxygen supply is cut off by ice. When a pond freezes, the water's oxygen content cannot be replenished because there is no contact with air. If only parts of the surface can be kept free of ice, however, water can aerate itself and the fish can survive the bleak months.

The same conservationists have also learned that ice formation can be slowed or stopped completely by raising the slightly warmer waters from the depths of a pond or lake. A few degrees of heat stave off freezing. The problem has been to develop economic devices to raise the water in large quantities. Pumps and propellers work all right but if supplied in sufficient numbers, operation costs would be prohibitive.

Attempts to use compressed air for keeping water bodies open during winter occurred as early as 1930. A perforated air line, hooked to a compressor, was run into a body of water. When the air was turned on, bubbles rose to the surface forcing the lower water up with them. (It should be stressed that the bubbles themselves do not significantly add oxygen to the water—it is the mixing action that is important.) The idea was sound but the experiments were largely unsuccessful because of the equipment. The compressors worked well enough, but laying and maintaining long lines of metal pipe was another matter. The pipe was heavy. Many connections had to be made. Hundreds of bubble holes had to be drilled. Once on the lake floor, the metallic pipe showed true orneriness. Its ponderous weight forced it into the muddy or sandy bottom and clogged the perforations. Rust eventually fouled holes the mud happened to miss. All in all, such systems were not very satisfactory.

Neither were other methods. One procedure called for sawing huge air slots into the ice. The slots worked suitably for a time but of course quickly froze over and had to be cut again. When the mercury dipped, sawing out the ice was necessary more and more frequently. Workers' ears and noses grew colder and colder. Blasting holes into the ice with light charges of explosives was more dramatic but produced about the same short-lived results.

Also the concussion defeated the purpose of saving fish.

Not until the recent development of plastic pipe did underwater lines come into their own. The pipe—usually polyethylene— is lightweight and economical. It bends easily, so few connections are needed. Its light weight keeps it from wallowing in the mud—indeed, it must be wrapped with lead cord to sink it in water. And moving the plastic pipe isn't nearly the problem that relocating iron pipe is. Other improvements have helped make underwater systems practical. New compressors start easily and run well in cold weather and certain modern lubricants work in temperatures far below freezing.

In plastic pipe anti-ice systems, the lines are usually placed directly on the bottom. If necessary, however, they can be located several feet up from the floor by attaching floats or by adjusting buoyancy with the amount of lead cord applied. Experience indicates that the pipe should be set at right angles to the local prevailing winds. Waves caused by the winds then help to break up the ice. The wave action will also assist in venting the toxic gases given off by the rotting vegetation on the pond or lake floor. (Some authorities believe these sulphides kill as many fish as does the shortage of oxygen in the water.)

Several of these bubble systems are at work in chilly Wisconsin, making winter life easier for both fish and waterfowl. One successful installation is at the Crystal Springs Fish Hatchery in northeastern Wisconsin. There, a large section of a spring-fed pond is kept ice free so that personnel may both observe and feed young trout. Approximately 250 feet of $^1/_2$-inch i.d. plastic pipe, perforated with $^1/_{64}$-inch holes at 1-foot intervals, rests just above the bottom of the pond. This line is connected to a 25-foot section of $^3/_4$-inch i.d. pipe extending to the receiver of an electricially powered rotary compressor in a service shack.

The system at Crystal Springs cost only $22.37 for 43 days of operation while running 15 hours per day. For a $157.61 investment an area 20×130 feet was kept ice free. In other cases privately owned hatcheries have used installations closely resembling this one to keep sections of their ponds open for the 2 months of coldest weather. Hatcheries that once suffered heavy annual winter kills now are on a year-round production basis.

At Rush Lake, in Winnebago County, Wis., a compressor and distribution set-up keep a stream free of ice. The stream feeds a snow-covered lake and prevents its oxygen from becoming depleted. During the 1956–57 winter some 39,000 northern pike were taken from the lake. If the bubble system hadn't been operating, probably all of these fish would have suffocated in oxygen-starved waters.

Another air compressor and hose project is in Vilas County, Wis., where the owner of a 60-acre lake has eliminated winter kill of a thick population of game fish. The air supply was adopted at the suggestion of a professional consultant.

The wiley muskellunge is often regarded as one of the more difficult species of fish to propagate, one reason being the fish's penchant for devouring its own young. But at one privately owned hatchery, new ideas in pellet feeding, combined with a system of agitating water with compressed air, have practically eliminated the cannabilism. Raising the muskies has proved a profitable business.

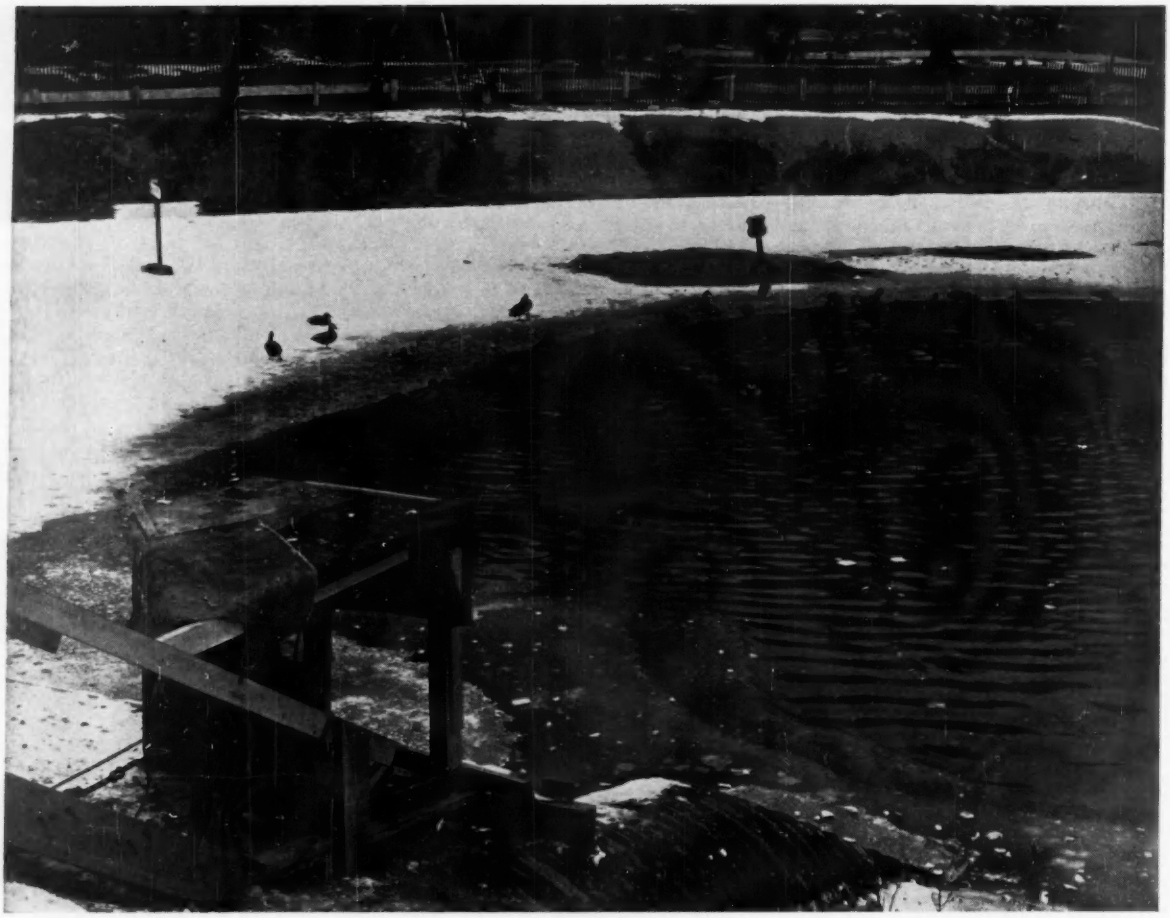
Perhaps the largest installation in Wisconsin has been in operation for several years at Milwaukee's lake-front Juneau Park. A good-sized compressor and a metal pipe system keep the lagoon open for a large flock of ducks that live there all year long. Aided by the air hook-up, pan fish thrive in the waters and provide wintering food for the ducks.

A single small air compressor is making it possible for dozens of mallards to spend this winter "at home" at Half Moon Lake in Eau Claire, Wis. During previous winters many of the ducks had to be chopped free of the ice at the lake because they wouldn't leave their favorite haunt in the fall. The Eau Claire Parks and Recreation Department decided to help the mallards this season in their stubborn refusal to head south. Temperatures at Eau Claire during the cold months often drop well below zero and the ice on the lake becomes at least 3 feet thick. Department personnel learned of the idea of keeping harbors and ferry lanes open and aiding waterfowl by bubble systems and decided to apply it.

A $^1/_2$-hp compressor is mounted on a

At Crystal Springs Fish Hatchery in northeastern Wisconsin, a plastic-pipe air system holds ice at bay (right). Personnel can continue to observe and feed the young trout and there is no danger of the fish suffocating.

Photos, Wisconsin Conservation Commission



MALLARDS GAMBOL IN A LAKE AT EAU CLAIRE, WIS., AS SUNKEN PIPE EMITS AIR FROM A COMPRESSOR, FOREGROUND.

small wooden platform on shore and is protected against the weather by canvas. Three hundred feet of plastic hose along the bottom of the lake releases compressed air through a series of perforations. The system operates all night, but on mild days when the approximately 200 mallards and 30 Canadian geese are active in the open water, the compressor is shut off.

The birds are fed corn, scratch feed and bread twice a day, and hundreds of spectators assemble especially on weekends, to watch the unusual winter sight of mallards and geese scooting about open water.

The Eau Claire Rod and Gun Club and the Westgate Gun Club have offered to help with the feed bill since they are naturally interested in increasing the local waterfowl population. The local game warden heartily approves of the project too, since besides aiding ducks the aeration provides oxygen for the bass and bluegills stocked in the lake. All in all, the Eau Claire installation has proved highly successful and the City Parks and Recreation Department is well satisfied. It is expected that the compressor will function each winter from now on so that the mallards and geese can live permanently at Half Moon Lake.

In Arizona there is a unique installation at 9000-foot elevation in a lake with a surface area of 575 acres. Winter kills at the lake had been an annual event. The cold is severe and ice has been known to form to a depth of 57 inches. The lake's average depth is only about 8 feet so the ice presented a grave threat to waterlife. An air system was installed consisting of 2400 feet of $1^1/_2$-inch i.d. plastic pipe with holes of $^1/_{16}$-inch diameter spaced at 15-foot intervals. At one time, when the ice was 13 inches deep and daytime temperatures hovered at about −26° F, a 210-cfm-capacity air compressor was put into operation. After 72 hours of continuous running, a channel 900 feet long had been opened to an average width of 20 feet. About 8 days later, with the compressor working 12 hours daily, the channel had grown to 1700 feet in length and 150 feet in width. The spring thaw revealed no dead fish. Apparently the air treatment, in combination with ice erosion caused by waves, had been applied well before an oxygen deficiency could develop. No cost figures are available, but no doubt the expense was especially justified since the state has few lakes that can support large fish populations.

Fishery personnel have not yet fully determined if essentially all dangers of winter kill can be eliminated by the bubble process. One related fact does seem clear. The bubbles must be at work shortly after ice forms (or preferably, before it does). If not, the natural oxygen supply may become almost completely depleted. There won't be time for the bubble system to thaw ice so that oxygen can be replenished.

Studies are underway to determine the economics of this new approach to keeping fish alive during the winter. To date, bubble systems have been placed only in relatively small lakes or ponds. Current research is aimed at finding if similar methods can economically keep fish from suffocating in much larger bodies of water.

EDITORIAL

Niagara Power

THE DATELINES in the nation's newspapers read Niagara Falls, N.Y., February 10. The stories hailed the first outflow of power from the $720 million project designed to claim this nation's share of the vast power potential of Niagara Falls. One of the ultimate thirteen 150,000-kw generators in the main (Lewiston) station spun out power for the first time that day. Before this magazine is printed, a second generator is expected to be on the line. Within 3 months, another will be in service, and fourth will be ready for duty, but on stand-by. All the power lost in 1956 when a landslide wiped out the previous American powerplant, Schoellkopf station, will then have been gained back.

The power project is to be completed July 1, 1963. At that time it will have a total capacity of 2,190,000 kw, making it the largest hydro plant in the free world. Owned and operated by the New York State Power Authority, the money necessary for the venture was derived from the sale of bonds without any form of governmental guaranties. By the time the project is finished, $78 million will have been taken into the coffers from the sale of power. After that date, an income of some $50 million annually will make it possible for the bonds to be paid off in 30 years, including debt service charges, plant operation and maintenance. A total of twelve contracts have been let for the purchase of this power, the largest single block going to Niagara Mohawk Power Corporation, owner of the lost Shoellkopf plant.

CONSTRUCTION and design details of this mammoth job have been reported previously in *Compressed Air Magazine*. Briefly, the job entailed construction of a pair of cut-and-cover conduits, excavation of a giant forebay, and construction of a vast pumped-storage pond and Lewiston and Tuscarora powerhouses. Lewiston, the main plant, takes water from the forebay through its turbines. Tuscarora, a pump/power station, lifts water from the forebay to the reservoir when surplus water and power are available, and then releases it to meet peak loads, generating power both in its own generators and finally in Lewiston's.

More energy is not to be the only result of the project, however. New York's Governor Nelson Rockefeller states that it will add about 6000 jobs to the economy of the surrounding territory. Visitor's dollars are also a major addition to treasuries, and a major rehabilitation in regards to parks, scenic drives and Falls' observation points has been undertaken for the benefit of tourists. These added developments, financed by the State of New York, bring the over-all cost of the work close to $1 billion.

The oft-asked question of the effect of power generation on the spectacle of the Falls has been well answered to the satisfaction of all. The diversion of some of the wearing water, plus the remedial steps undertaken, will actually preserve the Falls for future generations. This is a result that cannot be ignored in determining the total value of the work that has been done.

THE MAGNITUDE of the job is something that has to be seen to be believed. Although countless words have been written about its imaginative engineering, its years-ahead planning and its forceful execution, almost any superlative one picks seems to fall short in some respect.

TOTALS tell some of the story, but not all. For example, almost 30 million cubic yards of earth and rock had to be removed. This in itself was a sizable job for a vast quantity of compressors, and rock drills and other excavation equipment. What the totals don't say, however, is the care with which drilling had to be done. To make it possible for the huge conduits to be built with a minimum of concrete emplacement, line-hole drilling played a major role in the excavation of the trenches. A number of multiple-drill line-holing rigs were put to work on the project with the result that every contractor met or bettered his completion date.

The massive concrete which lines the walls of the conduits had to be firmly anchored to the surrounding rock. More than 60,000 holes, 3 inches in diameter and 8 feet deep, were drilled in the sides and bottoms of the conduit to take the anchor bolts that tied in the concrete. One subcontractor had jobs totalling more than $5,000,000 just for rock drilling and grouting to seal off tightly the project works from the percolating water that penetrates the underground formations around Niagara.

THAT this is one of the biggest construction jobs of recent years there is no doubt. When the last yard of concrete is poured and the last power line strung, it will be heralded as one of the great engineering and construction accomplishments of our time. We'd like to point out, if not already apparent, that it is also big in its use of compressed air power. To the farsighted planners who conceived and designed it, to the men of finance that saw to it that money was made available, and to the men and machines that built it, the Niagara Power Project will stand for some time to come as an outstanding working monument of their efforts.

PERIODIC PREVENTIVE MAINTENANCE

III. Percussive Tools

PERCUSSIVE pneumatic tools include chippers, diggers, riveters, nail drivers and caulking hammers; sand rammers and tie tampers; and scaling hammers. Although progressive manufacturers are using the highest quality standards, the best trained personnel available, and the latest scientific equipment in perfecting these tools and the metal that goes into them, the tools are of little extended value if maintenance is forgotten.

Chippers

The throttle linkage of chipping hammers should receive regular inspection and periodic maintenance. Wear in this area leads to inefficient power output. For example, a worn rubber seal, inexpensive and easy to replace, would lead directly to poor throttle control and excessive compressed air loss through lack of sealing when the throttle lever is released. Power loss can be closely associated to worn throttle levers and throttle valve stems and plungers; loss of full travel results in incomplete valve opening.

Another important part for inspection is the steel nozzle pressed into the barrel of the tool. This nozzle, rather than the more costly barrel, absorbs the wear from the chisel and can be replaced. When the inside diameter of the nozzle becomes badly worn, air is lost by bleeding between the chisel shank and nozzle, resulting in poor performance.

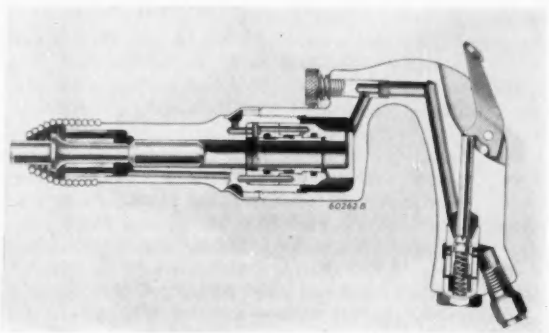
The worn nozzle hole also contributes to misalignment between the back end of the chisel and the striking end of the piston. The then glancing blows aggravate wear of the piston and barrel bore. Since barrel bore wear is not uniform, and since the wear to the barrel bore and piston causes reduction in power and performance, honing of the barrel bore is required. Standard oversized pistons are available to restore the tool to A-1 performance and power.

Because honing equipment can be expensive, when such wear is noted, the tool should be returned to the manufacturer's repair depot for maintenance. The user can be assured that even with the oversized piston, the repaired tool will have its original power restored, other factors being equal. With the possibility of returning a tool to the manufacturer for replacement of worn parts, it is wise to select tools made by firms with a vast repair service network so the tool is not away from its production work for a long period.

Retainers and buffers which are used to hold the chisel or steel in the tool and prevent the piston from hitting the bridge do wear, but are easy to replace when the tool is apart during inspection and lubrication periods. If worn and not replaced, the barrel may break. Replacing broken or damaged parts, as described in the earlier articles of this series, will prevent the excessive wear which can lead to the total destruction of the tool. Regarding retainer-type chippers a rubber buffer, in good condition, is all that is required to prevent the piston from striking the inside of the barrel. But often tools that are returned to one manufacturer interviewed about planned programs of maintenance show that the rubber buffer is either missing or has been mutilated from misuse.

Another important check point on chippers is the tightness of the handle to the body or barrel. The periodic check requires the handle to be separated from the body of the pneumatic tool. These two parts must be put back together properly, drawn up to a specified torque limit. Although it seems a needless effort, it can be done quickly and efficiently—and the results pay off in air and tool-cost savings.

There has been developed, as a result of an experimental program, a simple and effective means to do the job. The amount of torque a wrench operator can put on the tool handle in tightening it is dependent, not on the size of the man, but rather on the length of the wrench handle used. For example, for small tools, aircraft riveters and scaling hammers, one manufacturer's recommended torque is 150 foot-pounds. This can be achieved with a 1 $^{1}/_{2}$-foot lever arm on the wrench. On chipping hammers, riveters, and sand rammers, the torque should be 500 foot-pounds—applied with a minimum 5-foot lever arm on the wrench. These torques will be achieved whether the operator is small



RIVETER This Ingersoll-Rand Size AVC121 Riveter with pistol grip shows major areas to be checked in maintenance. Power loss can be closely associated to worn throttle levers, valve stems and plungers. Because this model has a rubber bonded nozzle, it has no bridge. The nozzle should be inspected regularly, with the beehive retainer.

and slight of frame, or tall, heavy and muscular.

Diggers are similar in design to chippers, and periodic preventive maintenance is relatively the same with few exceptions such as the handle tightness. In diggers this is achieved by nuts and bolts rather than a screw thread fit. Further, barrels of diggers cannot be oversized as chippers because of their concentric diameters in barrel bore. Extended tool life can be had by returning such barrels to the manufacturer where grinding to standard oversizes is possible.

Sand Rammers

The throttle linkage mechanisms of sand rammers should receive preventive maintenance similar to those of chippers and diggers. Because of the nature of the areas in which rammers are used, seals are of special importance. If the packing area is not maintained, dirt getting into the bore could cause a great problem in scoring, as well as loss of compression through worn seals and packing.

One sand rammer manufacturer applies Garlock wiper seals with built-in lubrication. The wiping seal keeps dirt particles out. Such wipers are readily available and should be stocked by the tool user.

As with chippers, precise tightness of the backhead and barrel must be maintained. In one manufacturer's model, a 500 foot-pound torque is essential, achieved, as before, with a 5-foot lever arm on the wrench. If the tightness is less, the backhead may eventually loosen, allowing the piston to strike the valve seat. Progressive fatigue failure of the tool results in breakage. Replacement of the backhead and valve parts amount to about 40 percent of the original tool cost.

Lubrication of sand rammers is vital. Many sand rammers have built-in lubrication reservoirs. The operator must watch and refill these when necessary. This is not always convenient and is easily forgotten. Therefore air line lubricators or oilers are recommended. These should be carefully regulated so that the proper amount of oil is fed to the tool.

Scalers

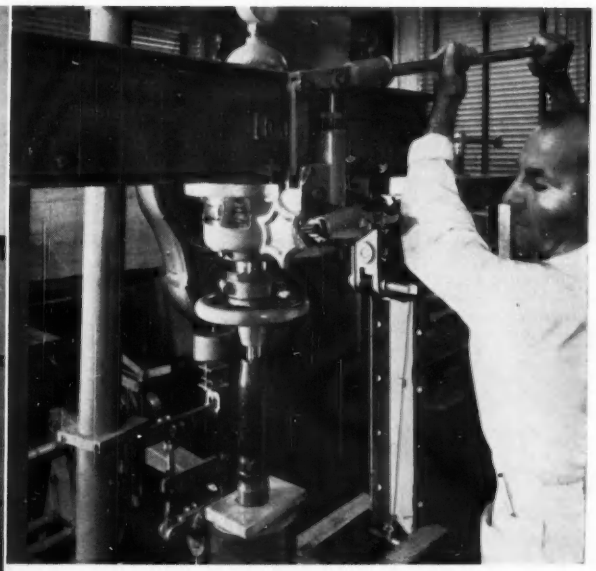
"Free air" cannot be tolerated by pneumatic tool users. Expenses lurk in the resulting inefficient tool operation. On scalers, then, the handle must be locked to the backhead to create an air seal as well as to insure proper functioning of valve parts. Again, replacing rubber throttle valve seals prevents loss of air when the tool is shut off.

Among the other vital parts for periodic maintenance are rings. In one manufacturer's model, O-rings are used in preventing the steel or chisel from leaving the tool. They also keep the piston from striking the bridge. If the O-rings are not kept in proper condition, by the nature of the tool's design and operation, vibration could cause the steels to fly out, damaging the tool, the piece being worked upon, and presenting an unsafe condition for the operator and persons standing nearby.

TAMPER This Ingersoll-Rand Size 441 Backfill Tamper has a One-Shot lubrication reservoir, but it must be filled to prevent excessive wear on moving parts. Above this reservoir is the throttle linkage mechanism that should receive periodic maintenance. Wiper seals are essential to keep dirt out of the tool. They are readily available and can be stocked by the tool user to good advantage. Without them, the tool will become clogged and the piston and barrel will wear quickly.

Percussive tools are specially designed to take rugged service—but, they cannot stand consistent abnormal abuse. Periodic preventive maintenance is a necessity for proper power output, prolonged working life and operator safety. Clean, lubricated moisture-free air is an absolute requirement.

—*S.M.P.*



NEW SERVICE LIFE In bringing a chipper back to its original performance rating, the barrel is honed on a Sunnen hone (left) to the next standard oversize. Then an oversized nozzle is pressed into the chipper barrel (above).

Industrial Notes

HANDLING bulk materials with bucket elevators is the subject of Bulletin 174. This 22-page booklet contains engineering data on various types of bucket elevators and recommends the grades of belting best suited for elevating materials of different weight, abrasiveness, temperature and other characteristics. One section deals with belt selection procedures based upon formulas developed from design experience. Another presents statistical tables about steel elevator buckets. There are also sections concerned with troubleshooting and belt splicing. *Hewitt-Robins Inc.*, 666 Glenbrook Road, Stamford, Conn.

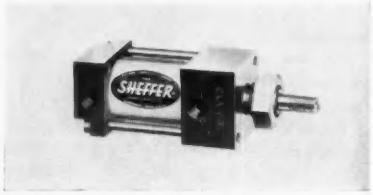
TO REMOVE scale, rust, sediment, suspended particles and the like from gases and liquids, Filterite Corporation's Microflow filter does an economical job. Model AM is for compressed air and gases. Its capacity is 15–200 cfm. Model LM, for oil, water and other liquids, has a capacity of 1–15 gpm. Operating pressure for each model is 125 psig. Cartridges for the Microflow are available in

bleached cotton, cellulose, acetate, Orlon, nylon, Dynel, jute or glass fiber. Particle removal is said to be 1 to 100 microns. The unit's large sump capacity increases the time between clean-outs. Further information is given in Bulletin 1119, available without charge. *Filterite Corporation*, Timonium, Md.

IMPOLENE can be used at operating temperatures to 300° F and working pressures to 450 psig, according to the manufacturer of this stabilized polypropylene tubing. It has 30 to 50 times the life of nylon at elevated temperatures, and can be repeatedly steam sterilized. Impolene has longer usable life than other thermoplastic tubings because there is no gradual change in physical properties under adverse conditions. Furthermore, it resists corrosion, concentrated hydrochloric acid and saline solutions. As for absorption, it is said to have nearly zero water absorption and a very low rate for mineral and vegetable oils. Product Report No. 301, available without charge, gives full details about Impolene for new plastic tubing applications. *Imperial-Eastman Corporation*, 6300 W. Howard Street, Chicago 48, Ill.

SLIDING gate and plate control valves are the subject of 8-page catalog J170-1. The units are recommended for use with air, steam, water, oil, gas and chemicals, and are available in sizes ranging from $^1/_4$ inch to 6 inches. Applications, operating features and characteristics, materials of construction, pressure and temperature limitations, photographs and cut-sections, flow curves, sizing charts and sample specifications are all included in the brochure. Also explained is the operation of the sliding gate and plate seats, showing how the seats give tight shut off, end wire drawing, give close control and reportedly operate at less than $^1/_3$ the noise level (by decibel count) of other types of control valves. *OPW-Jordan*, 6013 Wiehe Road, Cincinnati 13, Ohio.

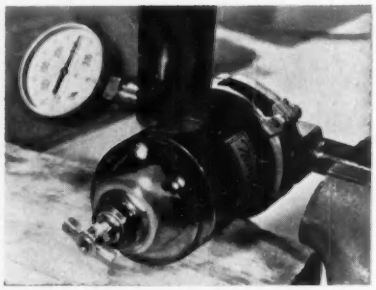
AN AIR cylinder of the stud-mounted $1^1/_8$-inch bore clamp type, for 150-psig air and 250-psig hydraulic pressure service, may be had in double-acting or spring-return models. Each is $1^1/_2$ inches square with a very short over-all length and a very light weight as a result of its having been machined from aluminum bar stock. A sintered bronze bushing in the rod head gives good bearing surface for the stainless steel piston rod. Rod seals are of block vee type for positive seal with low friction factor. Cylinder tubes are mirror-smooth drawn brass. Head seals are flat gaskets, retained type, to prevent extrusion. Ports are $^1/_8$-inch dry seal pipe thread. A free bulletin gives complete details of the line. *The Sheffer Corporation*, 326 W. Wyoming Avenue, Cincinnati 15, Ohio.



CONCRETE spraying machines feature a built-in rotor to assure the continuous discharge of premixed material into pressurized spraying lines. The premixed aggregates and cement are fed into a hopper equipped with a sieve and agitator. It is then transported through circular segmented rotor chambers to a discharge outlet and injected into the delivery line, where it is piped under 15-psig pressure air to a spray nozzle. Water is injected at the nozzle through a spray ring. The rotor is driven through a reduction gear by a pneumatic, or electric, motor. *Meynadier & Cie. A.G.*, Vulkanstrasse 110, Zurich 48, Switzerland.

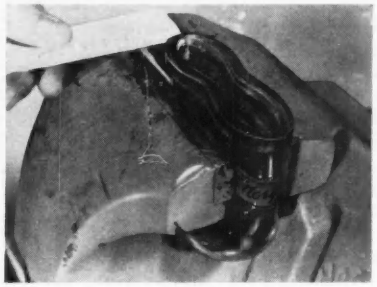
ANTI-NOISE is the bailiwick of a plastic ear plug made by American Optical Company. The device, called Hear-Guard, is about $^3/_4$ inch long and comes in three sizes: small, medium and large. The plugs are white in color and contain a safety tab for easy and safe insertion. While Hear-Guard sharply reduces industrial noises, it still permits the wearer to hear conversation. *American Optical Company*, Southbridge, Mass.

ALTHOUGH it looks like a standard transparent bowl, the one pictured is unbreakable. For Norgren air line filters



and lubricators, it offers superior resistance to solvents, oils, or corrosive gases, say company spokesmen. The

toughness of the bowl is demonstrated below. It was squeezed almost flat in a vise, as shown, then turned and compressed again. There was no evidence of cracking or breaking. In another test, a bowl under 265-psig pressure was pierced by a .22 long-rifle hollow-nose bullet. It passed through one side but was stopped by the second, without shattering, breaking or cracking the bowl itself. Or again, when internal pressure was increased to ten times the normal, the bowl only developed a blow hole. When a heavy steel bar was dropped from a height of 12 feet on a bowl under a pressure of 200 psig, the impact merely left a superficial scuff. With such a development, bowl guards and



wire reinforcements are eliminated, yet visual inspection is still possible. Full information is available from the company. *C. A. Norgren Company*, Englewood, Colo.

PNEUMATION Model 103 S is a magnet-actuated air switch only $1^1/_2$ inches long and $^1/_2$ inch in diameter, weighing less than 2 ounces. Designed especially for pneumatic circuits where only a very low actuating force is available, the switch has no mechanical linkage or striking parts. It can be used in place of electrical components such as limit or pressure switches, solenoid valves, and other electrical devices in ordinary service as well as in areas where there is an explosion hazard. Features include (1) snap action when energized or de-energized by a small magnet on a moving member of a mechanism, (2) low air consumption, and (3) maximum pressure of 25 psig. Bleed rate is 0.05 scfm at 10 psig when de-energized, and zero when energized. The air switch can be used as a limit or proximity device to actuate remote position indicators or counters. It can also be coupled directly to relay valves in cut-off and sequential circuitry. Another use is for the remote indication of valve stem position in all types of processes. The low actuating force and small space features make it suitable for controllers as high-low alarms. It can be applied in automation of packaging equipment, filling and weighing scales, machine tool control circuits, conveying and materials handling equipment, too. *Associated Control Equipment, Inc.*, P. O. Box 136, Coraopolis, Pa.

ATLAS Type F and Type FS pressure-reducing valves for use with air, steam, water, and gas to initial pressures of 500 psig are discussed in catalog sheet F-8-60. The diaphragm-operated, single-seated, spring-loaded bronze body valves, recommended where simple, tight-seating units are needed for small volume capacities, have reduced pressure ranges of 50-225, 10-150 and 0-5 psig. Also described in the 2-color sheet is the Type FAC valve for initial pressures of 300 psig and reduced pressures of 25-150 and 1-75 psig. This valve is used in paint sprayers, drinking fountains, beverage dispensing equipment and similar applications. *Atlas Valve Company*, 280 South Street, Newark 5, N. J.

SERIES-E is an air dryer designed and engineered for the protection of pneumatic controls; it has a rated capacity of 10 scfm at 100-psig pressure. It is ideally suited for air conditioning and ventilating control systems, printing press and other pneumatic feeds, processing and production lines, and in many laboratory applications. The efficient unit dries air and gases by mechanical refrigeration. No cooling water is needed and ambient temperature variance problems are said to have been eliminated. Compact, the Series-E is enclosed in a steel

cabinet equipped for floor or wall mounting. It is available as a basic unit (no trap), Model E-10; with the Hankison Mag-Pneu-Power automatic trap, Model E-10T; or with the Armstrong No. 21 trap, Model E-10C. The unit measures $20\ ^1/_8 \times 14 \times 12$ inches and weighs about 60 pounds. *Hankison Corporation*, College & Pike, Canonsburg, Pa.

STANLEY, a name well-known to hardware purchasers, has developed a line of Magic-Door pneumatic operators. It is offered in seven basic packages that simplify selection of automatic door operating equipment to meet the requirements of specific industrial applications. Operators are full-powered for both opening and closing. Speed may be regulated from slow to superfast—

which is reported to be three times faster than electric operators. The versatility of the pneumatic operators makes them adaptable to any type of industrial door that swings, slides or folds. Simplified design makes it possible to have minimum interruption of business operation. Further information on Magic-Door is available from the manufacturer. *The Stanley Works*, Magic Door Sales, Stanley Hardware, Department PD, 195, Lake Street, New Britain, Conn.

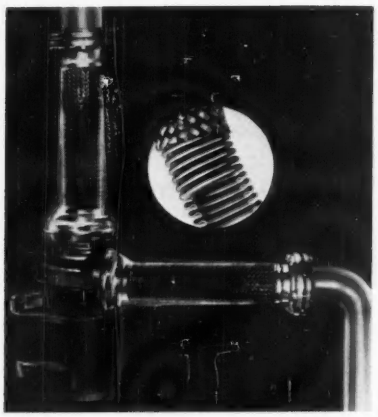
HANDI-BLAST is a portable sandblaster. It is designed for use throughout industry where fast, economical sandblasting is necessary for a multitude of different applications, yet the unit requires no more air than a production spray gun. Air is consumed at a rate of about 8 cfm, using the furnished $^{3}/_{32}$-inch nozzle and a 2-hp compressor. A $^{5}/_{32}$-inch nozzle, which can also be obtained with the unit, will consume approximately 20 cfm, requiring air supplied from a 5-hp compressor. The Handi-Blast operates with abrasives between 20 and 100 pound mesh. The over-all height of the unit is 23 inches and the tank diameter is 7 inches. It weighs 23 pounds empty and has an abrasive capacity of 30 pounds of sand. Each sandblaster is tested at 300-psig pressure. Some of the distinctive features reported by the manufacturer include a built-in sand funnel, an automatic opening and closing filler valve, a specially designed Vari-Flow air-operating valve, and a mixing chamber that mixes abrasive and air under the tank.

This last feature achieves two benefits: blasting air does not travel through the abrasive tank, thereby assuring no entrapment of air line moisture; and abrasive enters the air stream under pressure at the inlet end of delivery hose, allowing the abrasive to accelerate through the 8 feet of hose, and enter the nozzle at considerable speed. *Hamill Manufacturing Company, Inc.*, Washington, Mich.

TROUBLESOME effects of pipeline vibration, misalignment, or thermal expansion in pump installations are absorbed or reduced by flexible pump connectors called H. A. P. These pump connectors are recommended for all suction and discharge lines. Though there might be little inherent vibration in the pump itself when installed, any minor unbalance in the shaft will eventually magnify and cause vibration. Further, slight misalignment may stress the housing and cause undue wear on the bearings. In addition, thermal expansion develops heavy stresses, particularly when temperature fluctuations are high or frequent. Proper installation, according to Allied Metal Hose Company, calls for one such connection at both the suction and discharge end of a pump, as shown in the illustration.

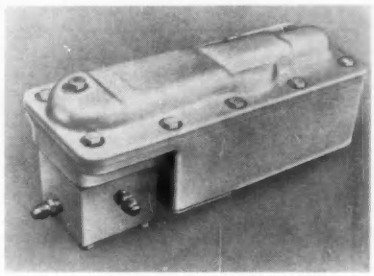
Consisting of a short section of corrugated flexible metal tubing (*see inset*), protected against pressure elongation by wire braid, these connectors are furnished with threaded or flanged end connections to fit all standard piping and are available in sizes from $^{1}/_{4}$ inch through 16 inches in stainless steel; $^{1}/_{4}$–8, bronze and hot-dip-galvanized steel; and $^{1}/_{4}$

inch through 4 inches in Monel. The connectors are individually engineered to the specific application for optimum results—and a wide range of standard stock configurations is obtainable. Material, length and construction are varied to suit the conveyed fluid, pressures, temperatures and movements encountered. In one typical construction, the flexible connector absorbs up to $^3/_8$-inch high-frequency vibration amplitude, up to $1^1/_2$-inch thermal pipeline expansion, and as much as 4 inches permanent



misalignment. H. A. P. pump connectors handle pressures to 1500 psig. Their helical, rather than annular, corrugations offer less resistance to flow, while distributing stresses along the entire hose length to minimize localized failures. The manufacturer reports a safety factor of each hose unit that is four times the rated working pressure. Temperatures handled may be as high as 1200° F. *Allied Metal Hose Company*, 8–14 Thirty-Eighth Avenue, Long Island City 1, N. Y.

ELECTRO-PNEUMATIC converters that transform d-c voltage or current variations into a pneumatic pressure signal have been developed by Hagan Chemicals. Each unit is essentially a force-balance instrument, introducing the input current or voltage signal to a coil mounted on a rotatable beam that operates in the field of a permanent magnet. The coil force is balanced automatically by pneumatic pressure in a bellows capsule which is flexibly connected to the beam. The bellows pressure is also the output pneumatic signal and is directly proportional to input current or voltage signal. An outward thrust is provided to a beam-and-coil assembly that is exactly proportional to the input signal. This thrust causes the beam to rotate, changing the pneumatic pressure applied on a bellows capsule.

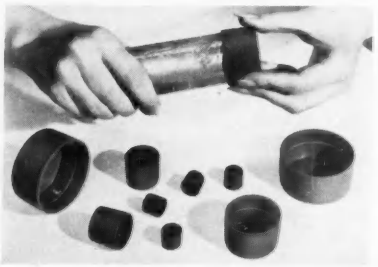


The converter will accept electrical input signals of 1–9 v or milliamps d-c, or 1–5 v or milliamps d-c. Pneumatic output signal ranges are 0–30, 0–15, 3–27, 3–15

"I found the trouble. One of the seals in the air pressure system was acting up."

psig, or the inverse of these ranges. The instrument is statically and dynamically balanced for resistance to shock and vibration. With a reported over-all accuracy of 0.5 percent of full scale, the converter's electrical system is temperature-compensated to maintain accuracy over a wide range of temperature conditions; the temperature coefficient is 0.25 percent per 100° F on range and 1 percent per 100° F on zero. Provided with a completely waterproof housing, the unit is unaffected by ambient temperatures to 120° F. Frequency response of the PowrMag converter is 2.5 cycles per second; linearity is ±0.5 percent of full scale; sensitivity is 0.025 percent of full scale. *Hagan Chemicals & Controls, Inc.*, Hagan Center, Pittsburgh 30, Pa.

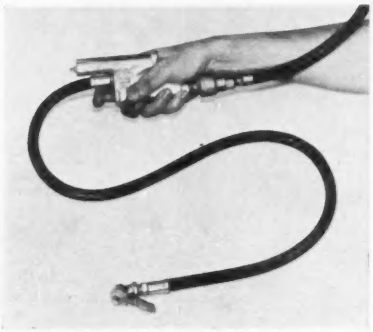
POLYETHYLENE pipe caps, a product of Clover Industries, Inc., are designated as 600 Series closures. They are designed to protect the exposed external end threads of iron and other piping and conduits, as well as to protect pipe from internal contamination. Color coded for easy identification, the pipe sizes range from a nominal $^1/_8$ inch to



2 inches. They feature a single internal thread, making them easy to apply—just a push and the pipe is sealed. Since the closures extend well beyond the threaded area, the threads are protected during painting, dipping and other process and handling operations. Because the caps are deeply knurled, they are easily removed by a simple twist. *Clover Industries, Inc.*, Department 30, 578 Young Street, Tonawanda, N. Y.

A METAL-BODIED air line chuck gauge that combines easy operation and dependable accuracy with simple component replacement has been announced by A. Schrader's Son. It saves time wherever tire service is required. The moment the chuck is placed on a tire valve, the tire pressure is registered on the built-in gauge. To deflate, a single control button is partially depressed; to inflate, it is fully depressed. Release of the button instantly provides the new pressure reading. Schrader chuck gauge Model 3650, available with single- or dual-foot chucks, permits easy matching of equipment to tire service needs.

Model 3650C, with single-foot clip-on chuck and 3-foot hose, permits quick inflation and precise gauging from a dis-



tance—without danger of injury due to bead blow-off. Replacement gauge units, which are calibrated for a 16- to 110-psig pressure range, are easily installed without removing the aluminum chuck gauge housing from the air line, according to reports. The long-service-life O-ring operating valve parts are as easy to replace as the oil-resistant hoses. *Scovill Manufacturing Company, Inc.*, A. Schrader's Son Division, 470 Vanderbilt Avenue, Brooklyn 38, N. Y.

NICKEL-OVER-STEEL Division of M. L. Sheldon & Company, Inc., has published a brochure that describes how Niphos nickel-alloy-bonded steel pipe and tubing are being used increasingly to counter corrosion and iron contamination. According to the company, Niphos tubular steels combine the corrosion resistance of 98-percent nickel 2-percent phosphorus alloy with (1) ductility permitting 360-degree coiling and severe fabricating without peeling or flaking of the coating, (2) weldability by conventional welding procedures without destroying continuity of corrosion resistance, (3) capacity to withstand temperatures to 1000° F and pressures equal to those specified for the base steel, (4) protection on inside and outside diameters, (5) standard availability in any lengths and most diameters, (6) availability of complete range of fittings for all types of joints, and (7) cost at only a fraction of that of stainless. The booklet also excerpts a report made by the American Society of Mechanical Engineers which states that Niphos was ranked first "in order of apparent merit" among the stainless, low-alloy and metallic-coated steels tested by Detroit Edison Company. *M. L. Sheldon & Company, Inc.*, 350 Lexington Avenue, New York 16, N. Y.

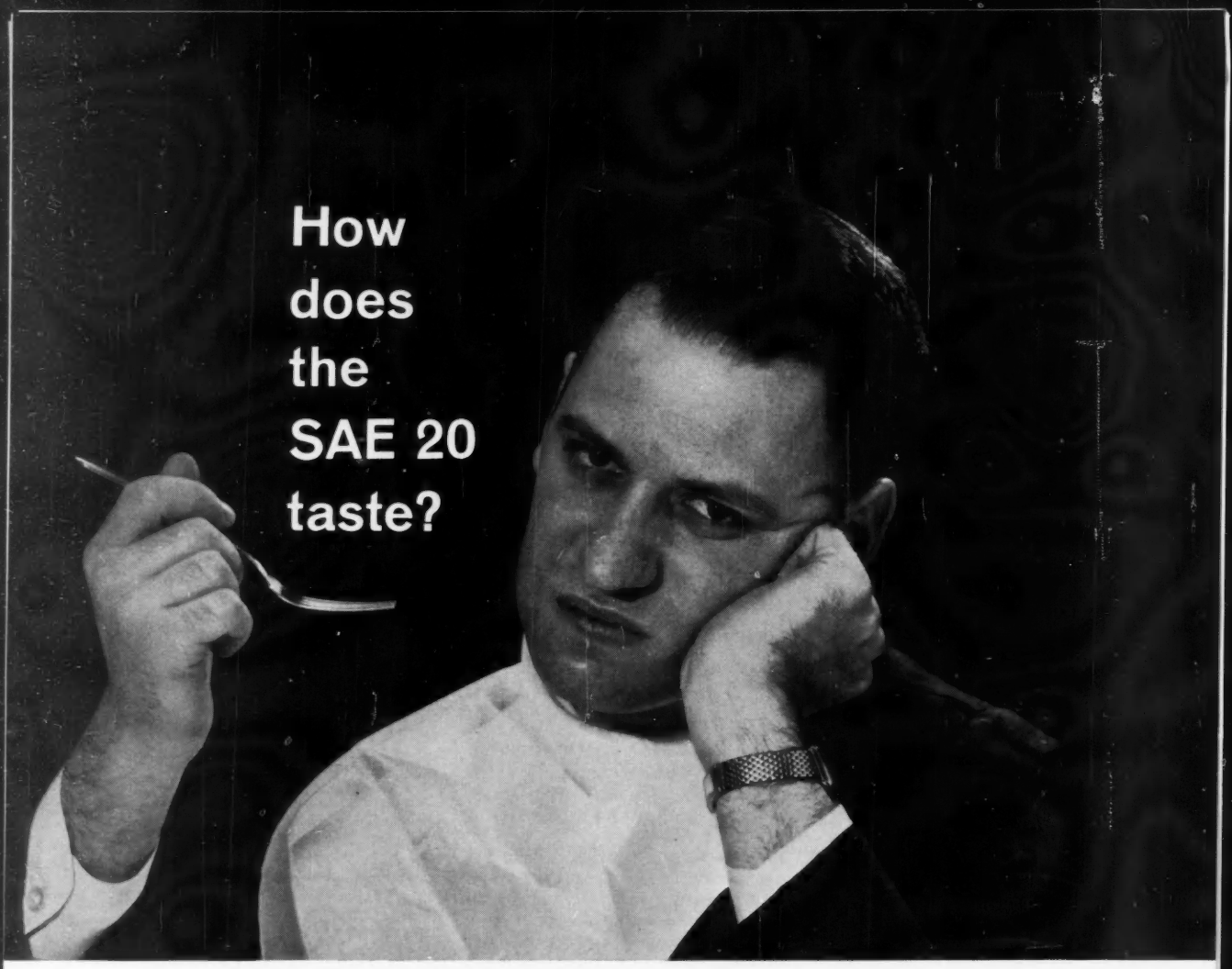
Books . . .

Handbook of Instrumentation and Controls, A Practical Manual for the Mechanical Services Covering Steam Plants, Power Plants, Heating Systems, Air-Conditioning Systems, Ventilation Systems, Diesel Plants, Refrigeration, and Water Treatment (published by McGraw-Hill, 327 W. Forty-First Street, New York 36, N. Y.) was written by Howard P. Kallen, a consulting engineer whose firm specializes in the design of mechanical services systems for commercial and industrial buildings. He is a mechanical engineer and former associate editor of *Power*. He is also a member of the American Society of Mechanical Engineers and the Instrument Society of America.

Kallen's book is planned to help the reader determine how to best select and effectively apply instruments and control systems for mechanical services by providing a wide range of authoritative and quantitative data. Extending from basic facts on instruments to thorough descriptions of complete control systems, this guide presents important information needed to procure, specify, or design equipment.

In treating instrumentation for pressure, temperature, flow, liquid level, pH and conductivity, combustion, and boiler controls, the needs of the engineer who designs and develops instruments, as well as the application engineer, were kept in mind. Yet, lengthy, complicated discussions are omitted in favor of many quick-reference data. Numerous clear illustrations—550 of them—and tables, charts and graphs are used to convey technical aspects of instrumentation. Of particular interest is the presentation of many control systems that are completely illustrated to demonstrate modern practice.

Specialized phases, including boiler and combustion controls, boiler flame-failure safeguards, and the fundamentals of instrument system design are covered. Also the book includes newer developments such as control systems for high-pressure steam power plants, and controls for large central air-conditioning systems. 692 pages. Cost, $15.



The slightest trace of lubricating oil, whatever its viscosity, is as deadly as poison in killing repeat sales of food products.

Oil contamination is a serious problem wherever compressed air is used for handling or processing foods — *unless* you have the proper compressor equipment engineered for oil-free operation by Ingersoll-Rand. The reputation of I-R compressors for reliability in heavy-duty service is unmatched on all types of jobs throughout the world.

Ingersoll-Rand builds the most complete line of equipment for oil-free compression of air or gas, including "NL" single- and double-acting reciprocating compressors, helical rotary Axi-compressors, and centrifugal compressors in a complete range of sizes. For more information, call your I-R engineering representative today. He can give valuable help on your job.

Ingersoll-Rand

129 A-14 11 Broadway, New York 4, N. Y.

THE WORLD'S MOST COMPREHENSIVE COMPRESSOR EXPERIENCE

Bethlehem wire rope supplies muscle for deepening Buffalo's harbor

Wire rope mill depots and distributors from coast to coast stock Bethlehem rope

Rigged entirely with Bethlehem wire rope, this 12 cu yd clamshell dredge is deepening the channel in Buffalo Harbor to facilitate the navigation of ships using the St. Lawrence Seaway. Operated by Great Lakes Dredge & Dock Company, the dredge is shown hard at work off the Niagara Frontier Port Authority Terminal.

The harbor improvement program is being undertaken in four stages at a cost of about $10 million. The work is due for completion in 1961.

The dredge operators are getting dependable performance from their Bethlehem wire rope. Whatever your construction work may be, you too, can rely on this fine rope for the really tough jobs.

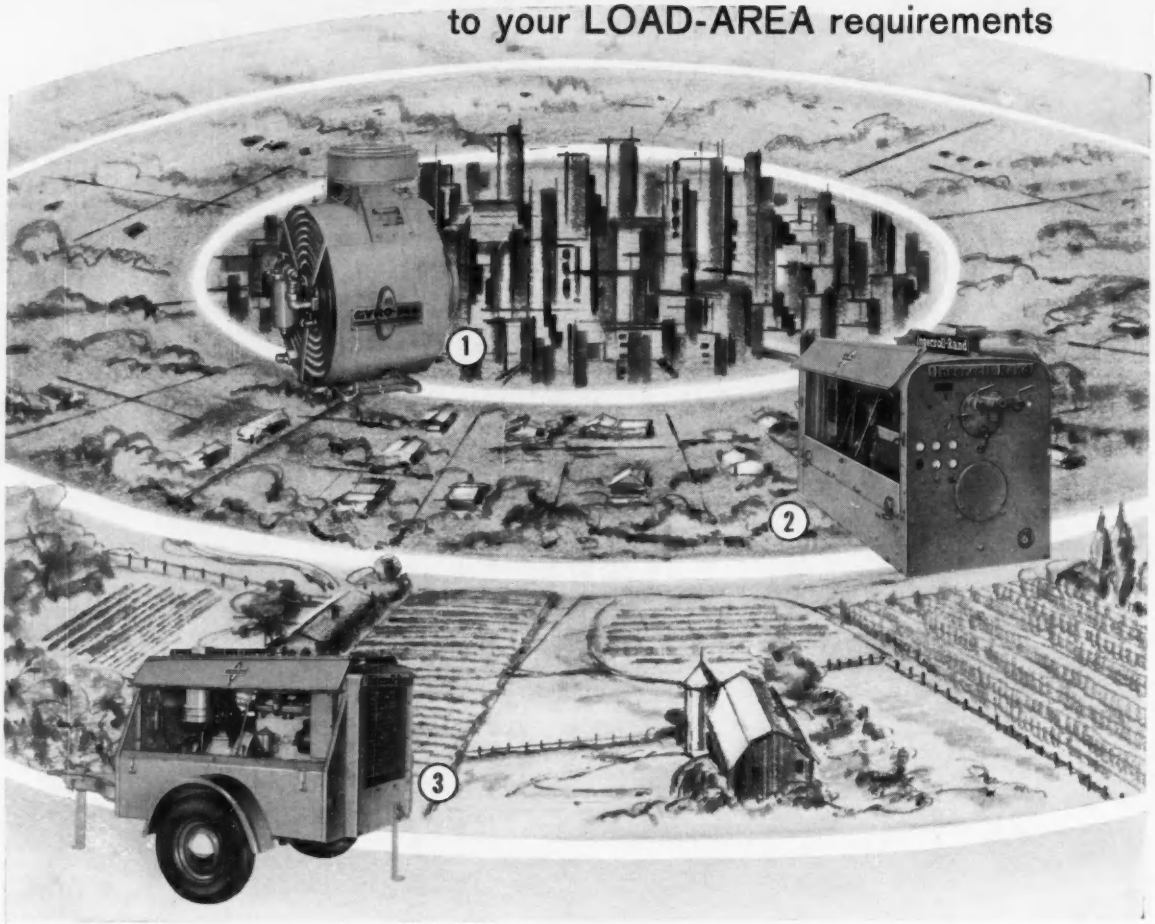
NEW CATALOG... "Bethlehem Wire Rope for Construction and Industrial Equipment" is a valuable reference of specific recommendations for the use of wire rope on bulldozers, shovels, derricks, cranes, and other equipment. Its 150 pages include data on grades, cores, and lays of wire rope, fittings, etc. Write today for your free copy. Ask for Catalog 493. Address your letter to Publications Dept., Bethlehem Steel Co., Bethlehem, Pa.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Sales: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

MATCH THE COMPRESSOR

to your LOAD-AREA requirements



Now you can get a GYRO-FLO portable compressor with the right combination of space, weight and power for any operating conditions

1. For METROPOLITAN AREAS

it's the Power-Takeoff unit

This super-compact Gyro-Flo compressor, for direct or belt drive from the service truck power-takeoff, is ideal for busy metropolitan areas where truck size must be kept to the minimum. These 85-cfm and 125-cfm compressors take less than 3.6 and 4.9 sq ft of floor space respectively, leaving plenty of extra space for men and equipment. Air-operated engine speed control and combination air receiver and oil separator can be mounted wherever convenient.

2. For SUBURBAN AREAS

it's the Self-Powered Truck-Mounted unit

Where larger service trucks can be used and space is less critical, self-powered 85-cfm and 125-cfm Gyro-Flo compressors for truck mounting offer the advantages of maximum fuel economy, simplicity of operation and reduced wear and tear on the truck motor. There are no gears, clutches or belts and the compressor can be removed to free the truck, if necessary, when only the compressor is needed on the job.

3. For OUTLYING AREAS

it's the Completely Self-Contained Portable unit

Where there's ample room for needed equipment at the job site, the completely self-contained Gyro-Flo portable compressor offers maximum convenience, flexibility and economy. You can tow it to the job and immediately release the truck for other work. Wheeled units are available in sizes from 85-cfm to 900-cfm, to meet any air power requirements.

Ask your Ingersoll-Rand Distributor or engineer for complete information on the Gyro-Flo that will meet your needs to best advantage.

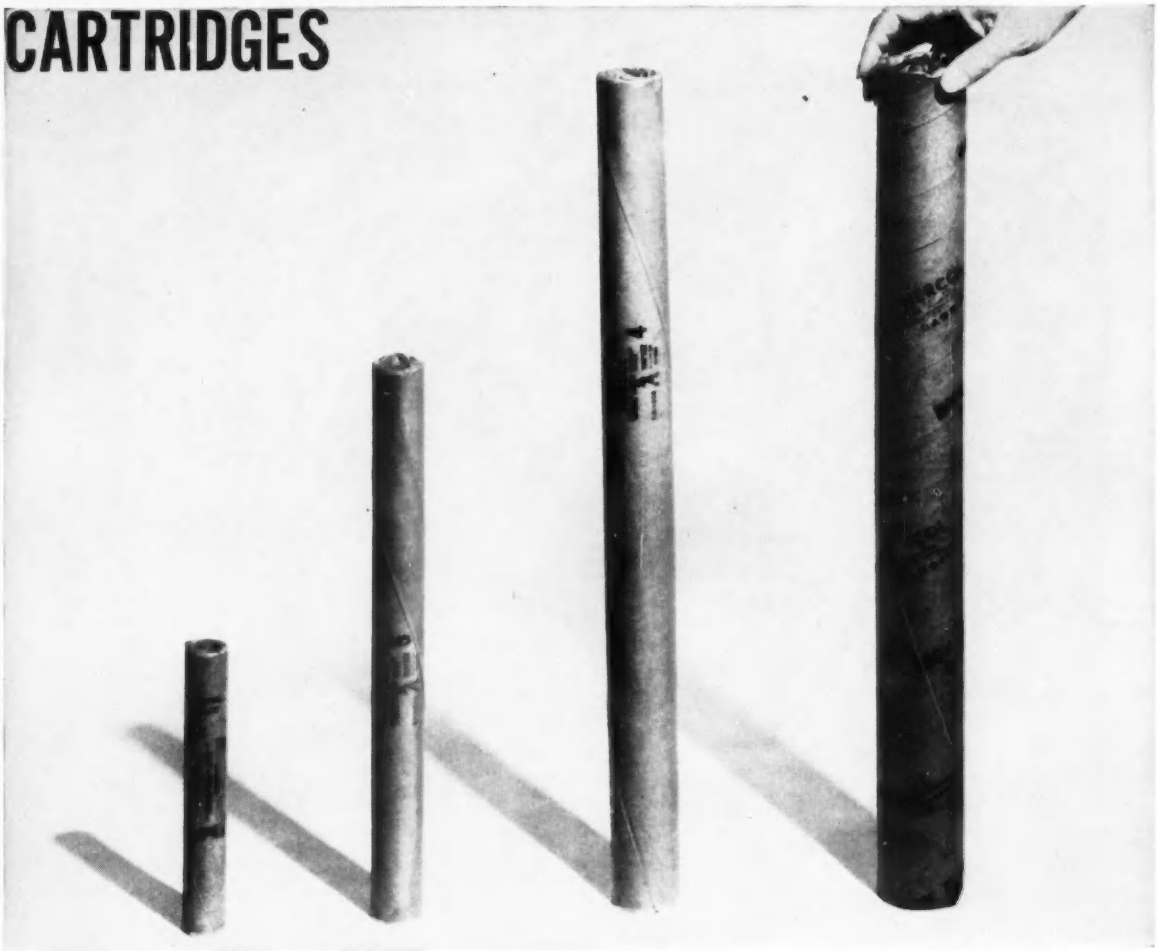
Ingersoll-Rand

196A2 ▼ 11 Broadway, New York 4, N. Y.

The World's Most Comprehensive Compressor Experience

ADVERTISERS INDEX

HERCOL®—A LOW-COST EXPLOSIVE—NOW AVAILABLE IN SMALL-DIAMETER CARTRIDGES



The Hercol series of low-cost, cap-sensitive, high-ammonia-content explosives are now available in cartridges of small diameters and standard lengths, as well as in the larger diameters and special packings.

The ability of Hercol to produce excellent fragmentation, its water resistance, Class 1 fumes, and high cartridge count—plus its low cost—have already been proved to the economy-minded quarry and open-pit operator.

Now that Hercol is manufactured in the smaller diameters, with Class 1 fumes, these same economies are available to the underground operator.

Contact the Hercules sales office nearest you or ask your Hercules representative for more detailed information on how Hercol can reduce blasting costs for you, too.

Properties of Hercol

	Hercol	Hercol 2	Hercol 4	Hercol 6
Fumes	Good	Good	Good	Good
Cartridge count—1¼ by 8-in. cartridges per 50 lb.	130	120	140	165
Cartridge diameter, in.	4 to 8½	1 to 3½	1 to 3½	1 to 3½
Weight strength, %	70	68	68	68
Cartridge strength, %	48	50	34	13
Water resistance	Fair	Good	Fair	Fair

A special grade of Hercol is formulated for seismic "pattern shooting" when the drill-holes are relatively dry.

Explosives Department

HERCULES POWDER COMPANY

INCORPORATED

900 Market Street, Wilmington, Delaware

XR60-1

BIRMINGHAM • CHICAGO • DULUTH • HAZLETON • JOPLIN • LOS ANGELES • NEW YORK • PITTSBURGH • SALT LAKE CITY • SAN FRANCISCO

new

JR-300 JACKDRILL

Challenges Comparison

50% Higher Drilling Speed and Easier Operation Assure Maximum Production at Lowest Capital Investment

Never before in the history of rock drilling has there been a feed-leg drill that could do so much, so easily, as Ingersoll-Rand's new JR-300 Universal Jackdrill. On performance alone, it is 40 to 60% faster than preceding models.

The JR-300 is a lightweight, completely integrated rock drill and flexible air-feed leg unit designed for faster, easier drilling in any position. Three feed legs are available with this new machine: conventional single-acting, telescopic and a new double-acting automatically retractable feed leg. All controls are conveniently grouped on the backhead and the feed handle has a two-position button for feed release or leg retraction which reduces steel changing time and speeds setups.

The same fine performance and design features are available in the new R-300 Stoper and J-300 Jackhamer, simplifying parts inventory where all three types of machines are used. For a new high in drilling speed and economy, ask your Ingersoll-Rand representative for a demonstration of the new JR-300 Universal Jackdrill—or send for a copy of Bulletin 4219 today.

Ingersoll-Rand
11 Broadway, New York 4, N. Y.

A CONSTANT STANDARD OF QUALITY IN EVERYTHING YOU NEED FOR DRILLING ROCK